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(54) Title: REGULATION OF HUMAN PHOSPHOLIPASE A2-LIKE ENZYME

(57) Abstract: Reagents which regulate human phospholipase A2-like enzyme and reagents which bind to human phospholipase A2-like enzyme gene products can play a role in preventing, ameliorating, or correcting dysfunctions or diseases including, but not limited to, asthma, cancer, inflammation, CNS disorders, cardiovascular disorders, chronic obstructive pulmonary disease, diabetes, and obesity.

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## REGULATION OF HUMAN PHOSPHOLIPASE A2-LIKE ENZYME

This application incorporates by reference co-pending Provisional Applications  
Serial No. 60/315,982 files August 31, 2001, Serial No. 60/258,051 files December  
5 27, 2000 and Serial No. 60/238,434 filed October 10, 2000.

## TECHNICAL FIELD OF THE INVENTION

The invention relates to the area of enzyme regulation. More particularly, the  
10 invention relates to human phospholipase A2-like enzyme and its regulation.

## BACKGROUND OF THE INVENTION

The secretory phospholipase A2 (PLA2) superfamily comprises a number of  
15 heterogeneous enzymes whose common feature is to hydrolyze the Serial No.-2 fatty  
acid acyl ester bond of phosphoglycerides. U.S. Patent No. 6,103,469. Hydrolysis of  
the glycerophospholipids releases free fatty acids and lysophospholipids. PLA2  
activity generates precursors for the biosynthesis of biologically active lipids,  
hydroxy fatty acids, and platelet-activating factor. Kramer *et al.*, FEBS Lett. 1997  
20 Jun 23;410(1):49-53, 1997.

PLA2 hydrolysis of the sn-2 ester bond in phospholipids generates free fatty acids,  
such as arachidonic acid and lysophospholipids. Arachidonic acid is processed into  
bioactive lipid mediators of inflammation, such as lyso-platelet-activating factor and  
25 eicosanoids. The synthesis of arachidonic acid from membrane phospholipids is the  
rate-limiting step in the biosynthesis of the four major classes of eicosanoids  
(prostaglandins, prostacyclins, thromboxanes and leukotrienes) involved in pain,  
fever, and inflammation. Furthermore, leukotriene-B4 is known to function in a  
feedback loop which further increases PLA2 activity. Wijkander *et al.*, *J. Biol.*  
30 *Chem.* 270, 26543-49, 1995.

- PLA2s, first described as components of snake venoms and pancreatic juice and later defined in mammals, have traditionally been classified into several major groups and subgroups based on their amino acid sequence, disulfide bond location, and divalent cation requirements. The PLA2s of groups I, II, and III consist of low molecular weight, secreted,  $\text{Ca}^{2+}$ -dependent proteins, Group IV PLA2s are primarily 85-kDa,  $\text{Ca}^{2+}$ -dependent cytosolic phospholipases, and an additional group comprises the  $\text{Ca}^{2+}$ -independent cytosolic phospholipases. Davidson & Dennis, *J. Mol. Evol.* 31, 228-38, 1990; Dennis, *J. Biol. Chem.* 269, 13057-13060, 1994.
- 10 The first PLA2s to be extensively characterized were the Group I, II, and III PLA2s found in snake and bee venoms. These venom PLA2s share many features with mammalian PLA2s, including a common catalytic mechanism, the same  $\text{Ca}^{2+}$  requirement, and conserved primary and tertiary structures. In addition to their role in the digestion of prey, the venom PLA2s display neurotoxic, myotoxic, 15 anticoagulant, and proinflammatory effects in mammalian tissues. This diversity of pathophysiological effects is due to the presence of specific, high affinity receptors for these enzymes on various cells and tissues. Lambeau *et al.*, *J. Biol. Chem.* 270, 5534-40, 1995.
- 20 At least four different groups of PLA2s have been characterized in mammalian cells, including Group I (pancreatic), Groups IIA, and IIC (inflammatory), and Group V (expressed in the heart). The pancreatic PLA2s function in the digestion of dietary lipids and have been proposed to play a role in cell proliferation, smooth muscle contraction, and acute lung injury. The inflammatory PLA2s are potent mediators of 25 inflammatory processes and are highly expressed in serum and synovial fluids of patients with inflammatory disorders. These Group II PLA2s are found in most human cell types assayed and are expressed in diverse pathological processes such as septic shock, intestinal cancers, rheumatoid arthritis, and epidermal hyperplasia. A Group V PLA2 has been cloned from brain tissue and is strongly expressed in heart 30 tissue. Other PLA2s have been cloned from various human tissues and cell lines, suggesting a large diversity of PLA2s. A human PLA2 was recently cloned from

fetal lung, and based on its structural properties, appears to be the first member of a new group of mammalian PLAs, referred to as Group X. Chen *et al.*, *J. Biol. Chem.* 269, 2365-68, 1994; Kennedy *et al.*, *J. Biol. Chem.* 270, 22378-85, 1995; Komada *et al.*, *Biochem. Biophys. Res. Commun.* 168, 1059-65, 1990; and Cupillard *et al.*, *J. Biol. Chem.* 272, 15745-52, 1997).

The discovery of a new human phospholipase A2 protein and the polynucleotides encoding it satisfies a need in the art by providing new compositions which are useful in the diagnosis, prevention, and treatment of asthma, cancer, inflammation, CNS disorders, cardiovascular disorders, chronic obstructive pulmonary disease, diabetes, and obesity.

#### SUMMARY OF THE INVENTION

It is an object of the invention to provide reagents and methods of regulating a human phospholipase A2-like enzyme. This and other objects of the invention are provided by one or more of the embodiments described below.

One embodiment of the invention is a phospholipase A2-like enzyme polypeptide comprising an amino acid sequence selected from the group consisting of:

amino acid sequences which are at least about 51% identical to the amino acid sequence shown in SEQ ID NO: 2;

the amino acid sequence shown in SEQ ID NO: 2;

amino acid sequences which are at least about 51% identical to the amino acid sequence shown in SEQ ID NO: 4;

the amino acid sequence shown in SEQ ID NO:4;



amino acid sequences which are at least about 51% identical to the amino acid sequence shown in SEQ ID NO: 9; and

the amino acid sequence shown in SEQ ID NO: 9.

5

Yet another embodiment of the invention is a method of screening for agents which decrease extracellular matrix degradation. A test compound is contacted with a phospholipase A2-like enzyme polypeptide comprising an amino acid sequence selected from the group consisting of:

10

amino acid sequences which are at least about 51% identical to the amino acid sequence shown in SEQ ID NO: 2;

the amino acid sequence shown in SEQ ID NO: 2;

15

amino acid sequences which are at least about 51% identical to the amino acid sequence shown in SEQ ID NO: 4;

the amino acid sequence shown in SEQ ID NO: 4;

20

amino acid sequences which are at least about 51% identical to the amino acid sequence shown in SEQ ID NO: 9; and

the amino acid sequence shown in SEQ ID NO: 9.

25

Binding between the test compound and the phospholipase A2-like enzyme polypeptide is detected. A test compound which binds to the phospholipase A2-like enzyme polypeptide is thereby identified as a potential agent for decreasing extracellular matrix degradation. The agent can work by decreasing the activity of the phospholipase A2-like enzyme.

30

Another embodiment of the invention is a method of screening for agents which decrease extracellular matrix degradation. A test compound is contacted with a polynucleotide encoding a phospholipase A2-like enzyme polypeptide, wherein the polynucleotide comprises a nucleotide sequence selected from the group consisting of:

- 5 of:
  - nucleotide sequences which are at least about 50% identical to the nucleotide sequence shown in SEQ ID NO: 1;
  - 10 the nucleotide sequence shown in SEQ ID NO: 1;
  - nucleotide sequences which are at least about 50% identical to the nucleotide sequence shown in SEQ ID NO: 3; and
  - 15 the nucleotide sequence shown in SEQ ID NO: 3.

Binding of the test compound to the polynucleotide is detected. A test compound which binds to the polynucleotide is identified as a potential agent for decreasing extracellular matrix degradation. The agent can work by decreasing the amount of the phospholipase A2-like enzyme through interacting with the phospholipase A2-like enzyme mRNA.

Another embodiment of the invention is a method of screening for agents which regulate extracellular matrix degradation. A test compound is contacted with a phospholipase A2-like enzyme polypeptide comprising an amino acid sequence selected from the group consisting of:

- 25 amino acid sequences which are at least about 51% identical to the amino acid sequence shown in SEQ ID NO: 2;
- 30 the amino acid sequence shown in SEQ ID NO: 2;

amino acid sequences which are at least about 51% identical to the amino acid sequence shown in SEQ ID NO: 4;

5 the amino acid sequence shown in SEQ ID NO:4;

amino acid sequences which are at least about 51% identical to the amino acid sequence shown in SEQ ID NO: 9; and

10 the amino acid sequence shown in SEQ ID NO: 9.

A phospholipase A2-like enzyme activity of the polypeptide is detected. A test compound which increases phospholipase A2-like enzyme activity of the polypeptide relative to phospholipase A2-like enzyme activity in the absence of the test  
15 compound is thereby identified as a potential agent for increasing extracellular matrix degradation. A test compound which decreases phospholipase A2-like enzyme activity of the polypeptide relative to phospholipase A2-like enzyme activity in the absence of the test compound is thereby identified as a potential agent for decreasing extracellular matrix degradation.

20

Even another embodiment of the invention is a method of screening for agents which decrease extracellular matrix degradation. A test compound is contacted with a phospholipase A2-like enzyme product of a polynucleotide which comprises a nucleotide sequence selected from the group consisting of:

25

nucleotide sequences which are at least about 50% identical to the nucleotide sequence shown in SEQ ID NO: 1;

the nucleotide sequence shown in SEQ ID NO: 1;

30

nucleotide sequences which are at least about 50% identical to the nucleotide sequence shown in SEQ ID NO: 3;

the nucleotide sequence shown in SEQ ID NO: 3;

5

nucleotide sequences which are at least about 50% identical to the nucleotide sequence shown in SEQ ID NO: 8; and

the nucleotide sequence shown in SEQ ID NO: 8.

10

Binding of the test compound to the phospholipase A2-like enzyme product is detected. A test compound which binds to the phospholipase A2-like enzyme product is thereby identified as a potential agent for decreasing extracellular matrix degradation.

15

Still another embodiment of the invention is a method of reducing extracellular matrix degradation. A cell is contacted with a reagent which specifically binds to a polynucleotide encoding a phospholipase A2-like enzyme polypeptide or the product encoded by the polynucleotide, wherein the polynucleotide comprises a nucleotide sequence selected from the group consisting of:

20

nucleotide sequences which are at least about 50% identical to the nucleotide sequence shown in SEQ ID NO: 1;

25

the nucleotide sequence shown in SEQ ID NO: 1;

nucleotide sequences which are at least about 50% identical to the nucleotide sequence shown in SEQ ID NO: 3;

30

the nucleotide sequence shown in SEQ ID NO: 3;

nucleotide sequences which are at least about 50% identical to the nucleotide sequence shown in SEQ ID NO: 8; and

the nucleotide sequence shown in SEQ ID NO: 8.

5

Phospholipase A2-like enzyme activity in the cell is thereby decreased.

The invention thus provides a human phospholipase A2-like enzyme which can be used to identify test compounds which may act, for example, as activators or inhibitors at the enzyme's active site. Human phospholipase A2-like enzyme and fragments thereof also are useful in raising specific antibodies which can block the enzyme and effectively reduce its activity.

10

#### BRIEF DESCRIPTION OF THE DRAWINGS

15

Fig. 1 shows the DNA-sequence encoding a phospholipase A2-like enzyme Polypeptide (SEQ ID NO:1).

Fig. 2 shows the amino acid sequence deduced from the DNA-sequence of Fig.1 (SEQ ID NO:2).

20 Fig. 3 shows the DNA-sequence encoding a phospholipase A2-like enzyme Polypeptide (SEQ ID NO:3)

Fig. 4 shows the amino acid sequence deduced from the DNA-sequence of Fig. 3 (SEQ ID NO:4).

Fig. 5 shows the amino acid sequence of the protein identified by embl Accession No. AF065215 (SEQ ID NO:5).

25

Fig. 6 shows the amino acid sequence of a phospholipase A2-like enzyme polypeptide (SEQ ID NO:6).

Fig. 7 shows the amino acid sequence of a phospholipase A2-like enzyme polypeptide (SEQ ID NO:7).

30 Fig. 8 shows the DNA-sequence encoding a phospholipase A2-like enzyme Polypeptide (SEQ ID NO:8)

Fig. 9 shows the amino acid sequence of a phospholipase A2-like enzyme polypeptide (SEQ ID NO:9).

Fig. 10 BLASTP alignment of human phospholipase A2-like enzyme (SEQ ID NO:2) with the protein identified with embl Accession No. AF065215 (SEQ ID NO:5).

Fig. 11 shows the BLASTP alignment of human phospholipase A2-like enzyme (SEQ ID NO:2) against swiss|P49147|PA2Y\_CHICK.

Fig. 12 shows the HMMPFAM - alignment of 364\_1\_protein (SEQ ID NO:2) against pfam|hmm|C2.

Fig. 13 shows the BLASTP alignment of 364\_2\_protein (SEQ ID NO:4) with the protein identified with embl Accession No. AF065215 (SEQ ID NO:5).

Fig. 14 shows the BLASTP alignment of SEQ ID NO:4 with against swiss|P50392|PA2Y\_BRARE (SEQ ID NO:7).

Fig. 15 shows the BLASTP alignment of SEQ ID NO:4 against pdb|1CJY|1CJY-A.

Fig. 16 shows the BLASTP - alignment of 364\_newProtein (SEQ ID NO:9) against trembl|AF065215|AF065215\_1 (SEQ ID NO:5).

Fig. 17 shows the results of the expression profiling of human phospholipase A2-like enzyme mRNA in a whole-body screen

#### DETAILED DESCRIPTION OF THE INVENTION

The invention relates to an isolated polynucleotide encoding a phospholipase A2-like enzyme polypeptide and being selected from the group consisting of:

a) a polynucleotide encoding a phospholipase A2-like enzyme polypeptide comprising an amino acid sequence selected from the group consisting of:

amino acid sequences which are at least about 51% identical to  
the amino acid sequence shown in SEQ ID NO: 2;  
the amino acid sequence shown in SEQ ID NO: 2;

- amino acid sequences which are at least about 51% identical to  
the amino acid sequence shown in SEQ ID NO: 4;  
the amino acid sequence shown in SEQ ID NO:4;  
amino acid sequences which are at least about 51% identical to  
the amino acid sequence shown in SEQ ID NO: 9; and  
the amino acid sequence shown in SEQ ID NO: 9;
- 5
- b) a polynucleotide comprising the sequence of SEQ ID NOS: 1, 3 or 8;
- 10 c) a polynucleotide which hybridizes under stringent conditions to a polynucleotide specified in (a) and (b);
- d) a polynucleotide the sequence of which deviates from the polynucleotide sequences specified in (a) to (c) due to the degeneration of the genetic code;
- 15 and
- e) a polynucleotide which represents a fragment, derivative or allelic variation of a polynucleotide sequence specified in (a) to (d).
- 20 Furthermore, it has been discovered by the present applicant that a novel phospholipase A2-like enzyme, particularly a human phospholipase A2-like enzyme is a discovery of the present invention. Human phospholipase A2-like enzyme comprises the fragments, SEQ ID NOS:2, 4 and 9. Coding sequences for SEQ ID NOS:2, 4 and 9 are shown in SEQ ID NOS:1, 3 and 8, respectively, and are located on chromosome 15. Alignments of SEQ ID NOS: 2, 4 and 9 with known phospholipase A2 enzymes are shown in Figs. 10, 11, 14, 15 and 16.
- 25

Human phospholipase A2-like enzyme of the invention is expected to be useful for the same purposes as previously identified phospholipase A2 enzymes. Human phospholipase A2-like enzyme is believed to be useful in therapeutic methods to treat disorders such as asthma, cancer, inflammation, CNS disorders, cardiovascular dis-

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orders, chronic obstructive pulmonary disease, diabetes, and obesity. Human phospholipase A2-like enzyme also can be used to screen for human phospholipase A2-like enzyme activators and inhibitors.

5     Polypeptides

Human phospholipase A2-like enzyme polypeptides according to the invention comprise at least 6, 10, 15, 20, 25, 50, 75, 100, 125, 150, 175, 200, 225, 250, 275, 300, 325, 350, 375, 400, or 420 contiguous amino acids selected from the amino acid  
10     sequence shown in SEQ ID NO:2 or at least 6, 10, 15, 20, 25, 50, 75, 100, 125, 150, 175, or 180 contiguous amino acids selected from the amino acid sequence shown in SEQ ID NO:4 or at least 6, 10, 15, 20, 25, 50, 75, 100, 125, 150, 175, 200, 225, 250, 275, 300, 325, 350, 375, 400, 425, 450, 475, 500, 525, 550, 575, 600, 625, 650, 675, 700, 725, 750, 775, 800 or 802 contiguous amino acids selected from the amino acid  
15     sequence shown in SEQ ID NO:9 or biologically active variants of SEQ ID NOS:2, 4 or 9, as defined below. A phospholipase A2-like enzyme polypeptide of the invention therefore can be a portion of a phospholipase A2-like enzyme protein, a full-length phospholipase A2-like enzyme protein, or a fusion protein comprising all or a portion of a phospholipase A2-like enzyme protein.

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Biologically Active Variants

Human phospholipase A2-like enzyme polypeptide variants which are biologically active, e.g., retain a phospholipase A2 activity, also are phospholipase A2-like  
25     enzyme polypeptides. Preferably, naturally or non-naturally occurring phospholipase A2-like enzyme polypeptide variants have amino acid sequences which are at least about 51, 55, 60, 65, or 70, preferably about 75, 80, 85, 90, 96, 96, or 98% identical to the amino acid sequences shown in SEQ ID NOS:2, 4 or 9 or a fragment thereof. Percent identity between a putative phospholipase A2-like enzyme polypeptide  
30     variant and an amino acid sequence of SEQ ID NO:2, 4 or 9 is determined using the Blast2 alignment program (Blosom62, Expect 10, standard genetic codes).



Variations in percent identity can be due, for example, to amino acid substitutions, insertions, or deletions. Amino acid substitutions are defined as one for one amino acid replacements. They are conservative in nature when the substituted amino acid has similar structural and/or chemical properties. Examples of conservative replacements are substitution of a leucine with an isoleucine or valine, an aspartate with a glutamate, or a threonine with a serine.

Amino acid insertions or deletions are changes to or within an amino acid sequence. They typically fall in the range of about 1 to 5 amino acids. Guidance in determining which amino acid residues can be substituted, inserted, or deleted without abolishing biological or immunological activity of a phospholipase A2-like enzyme polypeptide can be found using computer programs well known in the art, such as DNASTAR software. Whether an amino acid change results in a biologically active phospholipase A2-like enzyme polypeptide can readily be determined by assaying for phospholipase A2 activity, as described for example, in the specific examples, below.

#### Fusion Proteins

Fusion proteins are useful for generating antibodies against phospholipase A2-like enzyme polypeptide amino acid sequences and for use in various assay systems. For example, fusion proteins can be used to identify proteins which interact with portions of a phospholipase A2-like enzyme polypeptide. Protein affinity chromatography or library-based assays for protein-protein interactions, such as the yeast two-hybrid or phage display systems, can be used for this purpose. Such methods are well known in the art and also can be used as drug screens.

A phospholipase A2-like enzyme polypeptide fusion protein comprises two polypeptide segments fused together by means of a peptide bond. The first polypeptide segment comprises at least 6, 10, 15, 20, 25, 50, 75, 100, 125, 150, 175,

200, 225, 250, 275, 300, 325, 350, 375, 400, or 420 contiguous amino acids selected from the amino acid sequence shown in SEQ ID NO:2 or at least 6, 10, 15, 20, 25, 50, 75, 100, 125, 150, 175, or 180 contiguous amino acids selected from the amino acid sequence shown in SEQ ID NO:4 or at least 6, 10, 15, 20, 25, 50, 75, 100, 125, 150, 175, 200, 225, 250, 275, 300, 325, 350, 375, 400, 425, 450, 475, 500, 525, 550, 575, 600, 625, 650, 675, 700, 725, 750, 775, 800 or 802 contiguous amino acids selected from the amino acid sequence shown in SEQ ID NO:9 or biologically active variants of SEQ ID NOS:2, 4 or 9, as defined below. those described above. The first polypeptide segment also can comprise full-length phospholipase A2-like enzyme protein.

The second polypeptide segment can be a full-length protein or a protein fragment. Proteins commonly used in fusion protein construction include  $\beta$ -galactosidase,  $\beta$ -glucuronidase, green fluorescent protein (GFP), autofluorescent proteins, including blue fluorescent protein (BFP), glutathione-S-transferase (GST), luciferase, horseradish peroxidase (HRP), and chloramphenicol acetyltransferase (CAT). Additionally, epitope tags are used in fusion protein constructions, including histidine (His) tags, FLAG tags, influenza hemagglutinin (HA) tags, Myc tags, VSV-G tags, and thioredoxin (Trx) tags. Other fusion constructions can include maltose binding protein (MBP), S-tag, Lex a DNA binding domain (DBD) fusions, GAL4 DNA binding domain fusions, and herpes simplex virus (HSV) BP16 protein fusions. A fusion protein also can be engineered to contain a cleavage site located between the phospholipase A2-like enzyme polypeptide-encoding sequence and the heterologous protein sequence, so that the phospholipase A2-like enzyme polypeptide can be cleaved and purified away from the heterologous moiety.

A fusion protein can be synthesized chemically, as is known in the art. Preferably, a fusion protein is produced by covalently linking two polypeptide segments or by standard procedures in the art of molecular biology. Recombinant DNA methods can be used to prepare fusion proteins, for example, by making a DNA construct which comprises coding sequences selected from the complement of SEQ ID NO:1

or 8 in proper reading frame with nucleotides encoding the second polypeptide segment and expressing the DNA construct in a host cell, as is known in the art. Many kits for constructing fusion proteins are available from companies such as Promega Corporation (Madison, WI), Stratagene (La Jolla, CA), CLONTECH  
5 (Mountain View, CA), Santa Cruz Biotechnology (Santa Cruz, CA), MBL International Corporation (MIC; Watertown, MA), and Quantum Biotechnologies (Montreal, Canada; 1-888-DNA-KITS).

#### Identification of Species Homologs

10

Species homologs of human phospholipase A2-like enzyme polypeptide can be obtained using phospholipase A2-like enzyme polypeptide polynucleotides (described below) to make suitable probes or primers for screening cDNA expression libraries from other species, such as mice, monkeys, or yeast, identifying cDNAs  
15 which encode homologs of phospholipase A2-like enzyme polypeptide, and expressing the cDNAs as is known in the art.

#### Polynucleotides

20

A phospholipase A2-like enzyme polynucleotide can be single- or double-stranded and comprises a coding sequence or the complement of a coding sequence for a phospholipase A2-like enzyme polypeptide. Partial coding sequences for human phospholipase A2-like enzyme are shown in SEQ ID NOS:1 and 3.

25

Degenerate nucleotide sequences encoding human phospholipase A2-like enzyme polypeptides, as well as homologous nucleotide sequences which are at least about 50, 55, 60, 65, 70, preferably about 75, 90, 96, or 98% identical to the nucleotide sequences shown in SEQ ID NOS:1, 3 and 8 or their complements also are phospholipase A2-like enzyme polynucleotides. Percent sequence identity between  
30 the sequences of two polynucleotides is determined using computer programs such as ALIGN which employ the FASTA algorithm, using an affine gap search with a gap

open penalty of -12 and a gap extension penalty of -2. Complementary DNA (cDNA) molecules, species homologs, and variants of phospholipase A2-like enzyme polynucleotides which encode biologically active phospholipase A2-like enzyme polypeptides also are phospholipase A2-like enzyme polynucleotides. Polynucleotides comprising at least 6, 7, 8, 9, 10, 12, 15, 18, 20, or 25 contiguous nucleotides of SEQ ID NO:1, 3 or 8 or its complement also are phospholipase A2-like enzyme polynucleotides. Such polynucleotides can be used, for example, as hybridization probes or antisense oligonucleotides.

10

Identification of Polynucleotide Variants and Homologs

Variants and homologs of the phospholipase A2-like enzyme polynucleotides described above also are phospholipase A2-like enzyme polynucleotides. Typically, homologous phospholipase A2-like enzyme polynucleotide sequences can be identified by hybridization of candidate polynucleotides to known phospholipase A2-like enzyme polynucleotides under stringent conditions, as is known in the art. For example, using the following wash conditions--2X SSC (0.3 M NaCl, 0.03 M sodium citrate, pH 7.0), 0.1% SDS, room temperature twice, 30 minutes each; then 2X SSC, 0.1% SDS, 50 °C once, 30 minutes; then 2X SSC, room temperature twice, 10 minutes each--homologous sequences can be identified which contain at most about 25-30% basepair mismatches. More preferably, homologous nucleic acid strands contain 15-25% basepair mismatches, even more preferably 5-15% basepair mismatches.

25

Species homologs of the phospholipase A2-like enzyme polynucleotides disclosed herein also can be identified by making suitable probes or primers and screening cDNA expression libraries from other species, such as mice, monkeys, or yeast. Human variants of phospholipase A2-like enzyme polynucleotides can be identified, for example, by screening human cDNA expression libraries. It is well known that the  $T_m$  of a double-stranded DNA decreases by 1-1.5 °C with every 1% decrease in

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homology (Bonner *et al.*, *J. Mol. Biol.* 81, 123 (1973). Variants of human phospholipase A2-like enzyme polynucleotides or phospholipase A2-like enzyme polynucleotides of other species can therefore be identified by hybridizing a putative homologous phospholipase A2-like enzyme polynucleotide with a polynucleotide having a nucleotide sequence of SEQ ID NO:1, 3 or 8 or the complement thereof to form a test hybrid. The melting temperature of the test hybrid is compared with the melting temperature of a hybrid comprising polynucleotides having perfectly complementary nucleotide sequences, and the number or percent of basepair mismatches within the test hybrid is calculated.

Nucleotide sequences which hybridize to phospholipase A2-like enzyme polynucleotides or their complements following stringent hybridization and/or wash conditions also are phospholipase A2-like enzyme polynucleotides. Stringent wash conditions are well known and understood in the art and are disclosed, for example, in Sambrook *et al.*, MOLECULAR CLONING: A LABORATORY MANUAL, 2d ed., 1989, at pages 9.50-9.51.

Typically, for stringent hybridization conditions a combination of temperature and salt concentration should be chosen that is approximately 12-20 °C below the calculated  $T_m$  of the hybrid under study. The  $T_m$  of a hybrid between a phospholipase A2-like enzyme polynucleotide having a nucleotide sequence shown in SEQ ID NO:1, 3 or 8 or the complement thereof and a polynucleotide sequence which is at least about 50, preferably about 75, 90, 96, or 98% identical to one of those nucleotide sequences can be calculated, for example, using the equation of Bolton and McCarthy, *Proc. Natl. Acad. Sci. U.S.A.* 48, 1390 (1962):

$$T_m = 81.5^{\circ}\text{C} - 16.6(\log_{10}[\text{Na}^+]) + 0.41(\%G + C) - 0.63(\%\text{formamide}) - 600/l,$$

where  $l$  = the length of the hybrid in basepairs.

Stringent wash conditions include, for example, 4X SSC at 65 °C, or 50% formamide, 4X SSC at 42 °C, or 0.5X SSC, 0.1% SDS at 65 °C. Highly stringent wash conditions include, for example, 0.2X SSC at 65 °C.

5     Preparation of Polynucleotides

10     A phospholipase A2-like enzyme polynucleotide can be isolated free of other cellular components such as membrane components, proteins, and lipids. Polynucleotides can be made by a cell and isolated using standard nucleic acid purification techniques, or synthesized using an amplification technique, such as the polymerase chain reaction (PCR), or by using an automatic synthesizer. Methods for isolating polynucleotides are routine and are known in the art. Any such technique for obtaining a polynucleotide can be used to obtain isolated phospholipase A2-like enzyme polynucleotides. For example, restriction enzymes and probes can be used to isolate polynucleotide fragments which comprises phospholipase A2-like nucleotide sequences. Isolated polynucleotides are in preparations which are free or at least 15 70, 80, or 90% free of other molecules.

20     Human phospholipase A2-like enzyme cDNA molecules can be made with standard molecular biology techniques, using phospholipase A2-like enzyme mRNA as a template. Human phospholipase A2-like enzyme cDNA molecules can thereafter be replicated using molecular biology techniques known in the art and disclosed in manuals such as Sambrook *et al.* (1989). An amplification technique, such as PCR, can be used to obtain additional copies of polynucleotides of the invention, using 25 either human genomic DNA or cDNA as a template.

30     Alternatively, synthetic chemistry techniques can be used to synthesize phospholipase A2-like enzyme polynucleotides. The degeneracy of the genetic code allows alternate nucleotide sequences to be synthesized which will encode a phospholipase A2-like enzyme polypeptide having, for example, an amino acid sequence shown in SEQ ID NO:2, 4 or 9 or a biologically active variant thereof.

Extending Polynucleotides

5 The partial sequences disclosed herein can be used to identify the corresponding full length gene from which they were derived. The partial sequences can be nick-translated or end-labeled with  $^{32}\text{P}$  using polynucleotide kinase using labeling methods known to those with skill in the art (BASIC METHODS IN MOLECULAR BIOLOGY, Davis *et al.*, eds., Elsevier Press, N.Y., 1986). A lambda library prepared from human tissue can be directly screened with the labeled sequences of interest or  
10 the library can be converted en masse to pBluescript (Stratagene Cloning Systems, La Jolla, Calif. 92037) to facilitate bacterial colony screening (see Sambrook *et al.*, MOLECULAR CLONING: A LABORATORY MANUAL, Cold Spring Harbor Laboratory Press (1989, pg. 1.20).

15 Both methods are well known in the art. Briefly, filters with bacterial colonies containing the library in pBluescript or bacterial lawns containing lambda plaques are denatured, and the DNA is fixed to the filters. The filters are hybridized with the labeled probe using hybridization conditions described by Davis *et al.*, 1986. The partial sequences, cloned into lambda or pBluescript, can be used as positive controls  
20 to assess background binding and to adjust the hybridization and washing stringencies necessary for accurate clone identification. The resulting autoradiograms are compared to duplicate plates of colonies or plaques; each exposed spot corresponds to a positive colony or plaque. The colonies or plaques are selected, expanded and the DNA is isolated from the colonies for further analysis and  
25 sequencing.

Positive cDNA clones are analyzed to determine the amount of additional sequence they contain using PCR with one primer from the partial sequence and the other primer from the vector. Clones with a larger vector-insert PCR product than the  
30 original partial sequence are analyzed by restriction digestion and DNA sequencing

to determine whether they contain an insert of the same size or similar as the mRNA size determined from Northern blot Analysis.

5 Once one or more overlapping cDNA clones are identified, the complete sequence of the clones can be determined, for example after exonuclease III digestion (McCombie *et al.*, *Methods* 3, 33-40, 1991). A series of deletion clones are generated, each of which is sequenced. The resulting overlapping sequences are assembled into a single contiguous sequence of high redundancy (usually three to five overlapping sequences at each nucleotide position), resulting in a highly accurate  
10 final sequence.

Various PCR-based methods can be used to extend the nucleic acid sequences disclosed herein to detect upstream sequences such as promoters and regulatory elements. For example, restriction-site PCR uses universal primers to retrieve  
15 unknown sequence adjacent to a known locus (Sarkar, *PCR Methods Applic.* 2, 318-322, 1993). Genomic DNA is first amplified in the presence of a primer to a linker sequence and a primer specific to the known region. The amplified sequences are then subjected to a second round of PCR with the same linker primer and another specific primer internal to the first one. Products of each round of PCR are  
20 transcribed with an appropriate RNA polymerase and sequenced using reverse transcriptase.

Inverse PCR also can be used to amplify or extend sequences using divergent primers based on a known region (Triglia *et al.*, *Nucleic Acids Res.* 16, 8186, 1988). Primers  
25 can be designed using commercially available software, such as OLIGO 4.06 Primer Analysis software (National Biosciences Inc., Plymouth, Minn.), to be 22-30 nucleotides in length, to have a GC content of 50% or more, and to anneal to the target sequence at temperatures about 68-72 °C. The method uses several restriction enzymes to generate a suitable fragment in the known region of a gene. The  
30 fragment is then circularized by intramolecular ligation and used as a PCR template.



Another method which can be used is capture PCR, which involves PCR amplification of DNA fragments adjacent to a known sequence in human and yeast artificial chromosome DNA (Lagerstrom *et al.*, *PCR Methods Applic. 1*, 111-119, 1991). In this method, multiple restriction enzyme digestions and ligations also can  
5 be used to place an engineered double-stranded sequence into an unknown fragment of the DNA molecule before performing PCR.

Another method which can be used to retrieve unknown sequences is that of Parker  
10 *et al.*, *Nucleic Acids Res. 19*, 3055-3060, 1991). Additionally, PCR, nested primers, and PROMOTERFINDER libraries (CLONTECH, Palo Alto, Calif.) can be used to walk genomic DNA (CLONTECH, Palo Alto, Calif.). This process avoids the need to screen libraries and is useful in finding intron/exon junctions.

When screening for full-length cDNAs, it is preferable to use libraries that have been  
15 size-selected to include larger cDNAs. Randomly-primed libraries are preferable, in that they will contain more sequences which contain the 5' regions of genes. Use of a randomly primed library may be especially preferable for situations in which an oligo d(T) library does not yield a full-length cDNA. Genomic libraries can be useful for extension of sequence into 5' non-transcribed regulatory regions.

20 Commercially available capillary electrophoresis systems can be used to analyze the size or confirm the nucleotide sequence of PCR or sequencing products. For example, capillary sequencing can employ flowable polymers for electrophoretic separation, four different fluorescent dyes (one for each nucleotide) which are laser  
25 activated, and detection of the emitted wavelengths by a charge coupled device camera. Output/light intensity can be converted to electrical signal using appropriate software (e.g. GENOTYPER and Sequence NAVIGATOR, Perkin Elmer), and the entire process from loading of samples to computer analysis and electronic data display can be computer controlled. Capillary electrophoresis is especially preferable  
30 for the sequencing of small pieces of DNA which might be present in limited amounts in a particular sample.

### Obtaining Polypeptides

Human phospholipase A2-like enzyme polypeptides can be obtained, for example, by  
5 purification from human cells, by expression of phospholipase A2-like enzyme  
polynucleotides, or by direct chemical synthesis.

### Protein Purification

10 Human phospholipase A2-like enzyme polypeptides can be purified from any cell  
which expresses the enzyme, including host cells which have been transfected with  
phospholipase A2-like enzyme expression constructs. A purified phospholipase A2-  
like enzyme polypeptide is separated from other compounds which normally  
associate with the phospholipase A2-like enzyme polypeptide in the cell, such as  
15 certain proteins, carbohydrates, or lipids, using methods well-known in the art. Such  
methods include, but are not limited to, size exclusion chromatography, ammonium  
sulfate fractionation, ion exchange chromatography, affinity chromatography, and  
preparative gel electrophoresis. A preparation of purified phospholipase A2-like  
enzyme polypeptides is at least 80% pure; preferably, the preparations are 90%, 95%,  
20 or 99% pure. Purity of the preparations can be assessed by any means known in the  
art, such as SDS-polyacrylamide gel electrophoresis.

### Expression of Polynucleotides

25 To express a phospholipase A2-like enzyme polynucleotide, the polynucleotide can  
be inserted into an expression vector which contains the necessary elements for the  
transcription and translation of the inserted coding sequence. Methods which are  
well known to those skilled in the art can be used to construct expression vectors  
containing sequences encoding phospholipase A2-like enzyme polypeptides and  
30 appropriate transcriptional and translational control elements. These methods  
include *in vitro* recombinant DNA techniques, synthetic techniques, and *in vivo*

genetic recombination. Such techniques are described, for example, in Sambrook *et al.* (1989) and in Ausubel *et al.*, CURRENT PROTOCOLS IN MOLECULAR BIOLOGY, John Wiley & Sons, New York, N.Y., 1989.

- 5 A variety of expression vector/host systems can be utilized to contain and express sequences encoding a phospholipase A2-like enzyme polypeptide. These include, but are not limited to, microorganisms, such as bacteria transformed with recombinant bacteriophage, plasmid, or cosmid DNA expression vectors; yeast transformed with yeast expression vectors, insect cell systems infected with virus
- 10 expression vectors (*e.g.*, baculovirus), plant cell systems transformed with virus expression vectors (*e.g.*, cauliflower mosaic virus, CaMV; tobacco mosaic virus, TMV) or with bacterial expression vectors (*e.g.*, Ti or pBR322 plasmids), or animal cell systems.
- 15 The control elements or regulatory sequences are those non-translated regions of the vector -- enhancers, promoters, 5' and 3' untranslated regions -- which interact with host cellular proteins to carry out transcription and translation. Such elements can vary in their strength and specificity. Depending on the vector system and host utilized, any number of suitable transcription and translation elements, including
- 20 constitutive and inducible promoters, can be used. For example, when cloning in bacterial systems, inducible promoters such as the hybrid lacZ promoter of the BLUESCRIPT phagemid (Stratagene, LaJolla, Calif.) or pSPORT1 plasmid (Life Technologies) and the like can be used. The baculovirus polyhedrin promoter can be used in insect cells. Promoters or enhancers derived from the genomes of plant
- 25 cells (*e.g.*, heat shock, RUBISCO, and storage protein genes) or from plant viruses (*e.g.*, viral promoters or leader sequences) can be cloned into the vector. In mammalian cell systems, promoters from mammalian genes or from mammalian viruses are preferable. If it is necessary to generate a cell line that contains multiple copies of a nucleotide sequence encoding a phospholipase A2-like enzyme
- 30 polypeptide, vectors based on SV40 or EBV can be used with an appropriate selectable marker.

### Bacterial and Yeast Expression Systems

5 In bacterial systems, a number of expression vectors can be selected depending upon the use intended for the phospholipase A2-like enzyme polypeptide. For example, when a large quantity of a phospholipase A2-like enzyme polypeptide is needed for the induction of antibodies, vectors which direct high level expression of fusion proteins that are readily purified can be used. Such vectors include, but are not limited to, multifunctional *E. coli* cloning and expression vectors such as  
10 BLUESCRIPT (Stratagene). In a BLUESCRIPT vector, a sequence encoding the phospholipase A2-like enzyme polypeptide can be ligated into the vector in frame with sequences for the amino-terminal Met and the subsequent 7 residues of  $\beta$ -galactosidase so that a hybrid protein is produced. pIN vectors (Van Heeke & Schuster, *J. Biol. Chem.* 264, 5503-5509, 1989) or pGEX vectors (Promega,  
15 Madison, Wis.) also can be used to express foreign polypeptides as fusion proteins with glutathione S-transferase (GST). In general, such fusion proteins are soluble and can easily be purified from lysed cells by adsorption to glutathione-agarose beads followed by elution in the presence of free glutathione. Proteins made in such systems can be designed to include heparin, thrombin, or factor Xa protease cleavage  
20 sites so that the cloned polypeptide of interest can be released from the GST moiety at will.

In the yeast *Saccharomyces cerevisiae*, a number of vectors containing constitutive or inducible promoters such as alpha factor, alcohol oxidase, and PGH can be used.  
25 For reviews, see Ausubel *et al.* (1989) and Grant *et al.*, *Methods Enzymol.* 153, 516-544, 1987.

### Plant and Insect Expression Systems

30 If plant expression vectors are used, the expression of sequences encoding phospholipase A2-like enzyme polypeptides can be driven by any of a number of

promoters. For example, viral promoters such as the 35S and 19S promoters of CaMV can be used alone or in combination with the omega leader sequence from TMV (Takamatsu, *EMBO J.* 6, 307-311, 1987). Alternatively, plant promoters such as the small subunit of RUBISCO or heat shock promoters can be used (Coruzzi *et al.*, *EMBO J.* 3, 1671-1680, 1984; Broglie *et al.*, *Science* 224, 838-843, 1984; Winter *et al.*, *Results Probl. Cell Differ.* 17, 85-105, 1991). These constructs can be introduced into plant cells by direct DNA transformation or by pathogen-mediated transfection. Such techniques are described in a number of generally available reviews (e.g., Hobbs or Murray, in MCGRAW HILL YEARBOOK OF SCIENCE AND TECHNOLOGY, McGraw Hill, New York, N.Y., pp. 191-196, 1992).

An insect system also can be used to express a phospholipase A2-like enzyme polypeptide. For example, in one such system *Autographa californica* nuclear polyhedrosis virus (AcNPV) is used as a vector to express foreign genes in *Spodoptera frugiperda* cells or in *Trichoplusia* larvae. Sequences encoding phospholipase A2-like enzyme polypeptides can be cloned into a non-essential region of the virus, such as the polyhedrin gene, and placed under control of the polyhedrin promoter. Successful insertion of phospholipase A2-like enzyme polypeptides will render the polyhedrin gene inactive and produce recombinant virus lacking coat protein. The recombinant viruses can then be used to infect *S. frugiperda* cells or *Trichoplusia* larvae in which phospholipase A2-like enzyme polypeptides can be expressed (Engelhard *et al.*, *Proc. Nat. Acad. Sci.* 91, 3224-3227, 1994).

#### Mammalian Expression Systems

A number of viral-based expression systems can be used to express phospholipase A2-like enzyme polypeptides in mammalian host cells. For example, if an adenovirus is used as an expression vector, sequences encoding phospholipase A2-like enzyme polypeptides can be ligated into an adenovirus transcription/translation complex comprising the late promoter and tripartite leader sequence. Insertion in a non-essential E1 or E3 region of the viral genome can be used to obtain a viable virus

which is capable of expressing a phospholipase A2-like enzyme polypeptide in infected host cells (Logan & Shenk, *Proc. Natl. Acad. Sci.* 81, 3655-3659, 1984). If desired, transcription enhancers, such as the Rous sarcoma virus (RSV) enhancer, can be used to increase expression in mammalian host cells.

5

Human artificial chromosomes (HACs) also can be used to deliver larger fragments of DNA than can be contained and expressed in a plasmid. HACs of 6M to 10M are constructed and delivered to cells via conventional delivery methods (e.g., liposomes, polycationic amino polymers, or vesicles).

10

Specific initiation signals also can be used to achieve more efficient translation of sequences encoding phospholipase A2-like enzyme polypeptides. Such signals include the ATG initiation codon and adjacent sequences. In cases where sequences encoding a phospholipase A2-like enzyme polypeptide, its initiation codon, and upstream sequences are inserted into the appropriate expression vector, no additional transcriptional or translational control signals may be needed. However, in cases where only coding sequence, or a fragment thereof, is inserted, exogenous translational control signals (including the ATG initiation codon) should be provided. The initiation codon should be in the correct reading frame to ensure translation of the entire insert. Exogenous translational elements and initiation codons can be of various origins, both natural and synthetic. The efficiency of expression can be enhanced by the inclusion of enhancers which are appropriate for the particular cell system which is used (see Scharf *et al.*, *Results Probl. Cell Differ.* 20, 125-162, 1994).

20  
25

#### Host Cells

A host cell strain can be chosen for its ability to modulate the expression of the inserted sequences or to process the expressed phospholipase A2-like enzyme polypeptide in the desired fashion. Such modifications of the polypeptide include, but are not limited to, acetylation, carboxylation, glycosylation, phosphorylation,

30

lipidation, and acylation. Post-translational processing which cleaves a "prepro" form of the polypeptide also can be used to facilitate correct insertion, folding and/or function. Different host cells which have specific cellular machinery and characteristic mechanisms for post-translational activities (*e.g.*, CHO, HeLa, MDCK, HEK293, and WI38), are available from the American Type Culture Collection (ATCC; 10801 University Boulevard, Manassas, VA 20110-2209) and can be chosen to ensure the correct modification and processing of the foreign protein.

Stable expression is preferred for long-term, high-yield production of recombinant proteins. For example, cell lines which stably express phospholipase A2-like enzyme polypeptides can be transformed using expression vectors which can contain viral origins of replication and/or endogenous expression elements and a selectable marker gene on the same or on a separate vector. Following the introduction of the vector, cells can be allowed to grow for 1-2 days in an enriched medium before they are switched to a selective medium. The purpose of the selectable marker is to confer resistance to selection, and its presence allows growth and recovery of cells which successfully express the introduced phospholipase A2-like enzyme sequences. Resistant clones of stably transformed cells can be proliferated using tissue culture techniques appropriate to the cell type. See, for example, ANIMAL CELL CULTURE, R.I. Freshney, ed., 1986.

Any number of selection systems can be used to recover transformed cell lines. These include, but are not limited to, the herpes simplex virus thymidine kinase (Wigler *et al.*, *Cell* 11, 223-32, 1977) and adenine phosphoribosyltransferase (Lowy *et al.*, *Cell* 22, 817-23, 1980) genes which can be employed in *tk*<sup>-</sup> or *aprt*<sup>-</sup> cells, respectively. Also, antimetabolite, antibiotic, or herbicide resistance can be used as the basis for selection. For example, *dhfr* confers resistance to methotrexate (Wigler *et al.*, *Proc. Natl. Acad. Sci.* 77, 3567-70, 1980), *npt* confers resistance to the aminoglycosides, neomycin and G-418 (Colbere-Garapin *et al.*, *J. Mol. Biol.* 150, 1-14, 1981), and *als* and *pat* confer resistance to chlorsulfuron and phosphinotricin acetyltransferase, respectively (Murray, 1992, *supra*). Additional selectable genes

have been described. For example, *trpB* allows cells to utilize indole in place of tryptophan, or *hisD*, which allows cells to utilize histinol in place of histidine (Hartman & Mulligan, *Proc. Natl. Acad. Sci.* 85; 8047-51, 1988). Visible markers such as anthocyanins,  $\beta$ -glucuronidase and its substrate GUS, and luciferase and its substrate luciferin, can be used to identify transformants and to quantify the amount of transient or stable protein expression attributable to a specific vector system (Rhodes *et al.*, *Methods Mol. Biol.* 55, 121-131, 1995).

#### Detecting Expression

Although the presence of marker gene expression suggests that the phospholipase A2-like enzyme polynucleotide is also present, its presence and expression may need to be confirmed. For example, if a sequence encoding a phospholipase A2-like enzyme polypeptide is inserted within a marker gene sequence, transformed cells containing sequences which encode a phospholipase A2-like enzyme polypeptide can be identified by the absence of marker gene function. Alternatively, a marker gene can be placed in tandem with a sequence encoding a phospholipase A2-like enzyme polypeptide under the control of a single promoter. Expression of the marker gene in response to induction or selection usually indicates expression of the phospholipase A2-like enzyme polynucleotide.

Alternatively, host cells which contain a phospholipase A2-like enzyme polynucleotide and which express a phospholipase A2-like enzyme polypeptide can be identified by a variety of procedures known to those of skill in the art. These procedures include, but are not limited to, DNA-DNA or DNA-RNA hybridizations and protein bioassay or immunoassay techniques which include membrane, solution, or chip-based technologies for the detection and/or quantification of nucleic acid or protein. For example, the presence of a polynucleotide sequence encoding a phospholipase A2-like enzyme polypeptide can be detected by DNA-DNA or DNA-RNA hybridization or amplification using probes or fragments or fragments of polynucleotides encoding a phospholipase A2-like enzyme polypeptide. Nucleic



acid amplification-based assays involve the use of oligonucleotides selected from sequences encoding a phospholipase A2-like enzyme polypeptide to detect transformants which contain a phospholipase A2-like enzyme polynucleotide.

5 A variety of protocols for detecting and measuring the expression of a phospholipase A2-like enzyme polypeptide, using either polyclonal or monoclonal antibodies specific for the polypeptide, are known in the art. Examples include enzyme-linked immunosorbent assay (ELISA), radioimmunoassay (RIA), and fluorescence activated cell sorting (FACS). A two-site, monoclonal-based immunoassay using monoclonal  
10 antibodies reactive to two non-interfering epitopes on a phospholipase A2-like enzyme polypeptide can be used, or a competitive binding assay can be employed. These and other assays are described in Hampton *et al.*, SEROLOGICAL METHODS: A LABORATORY MANUAL, APS Press, St. Paul, Minn., 1990) and Maddox *et al.*, *J. Exp. Med.* 158, 1211-1216, 1983).

15 A wide variety of labels and conjugation techniques are known by those skilled in the art and can be used in various nucleic acid and amino acid assays. Means for producing labeled hybridization or PCR probes for detecting sequences related to polynucleotides encoding phospholipase A2-like enzyme polypeptides include  
20 oligolabeling, nick translation, end-labeling, or PCR amplification using a labeled nucleotide. Alternatively, sequences encoding a phospholipase A2-like enzyme polypeptide can be cloned into a vector for the production of an mRNA probe. Such vectors are known in the art, are commercially available, and can be used to synthesize RNA probes *in vitro* by addition of labeled nucleotides and an appropriate  
25 RNA polymerase such as T7, T3, or SP6. These procedures can be conducted using a variety of commercially available kits (Amersham Pharmacia Biotech, Promega, and US Biochemical). Suitable reporter molecules or labels which can be used for ease of detection include radionuclides, enzymes, and fluorescent, chemiluminescent, or chromogenic agents, as well as substrates, cofactors, inhibitors, magnetic particles,  
30 and the like.

Expression and Purification of Polypeptides

Host cells transformed with nucleotide sequences encoding a phospholipase A2-like enzyme polypeptide can be cultured under conditions suitable for the expression and recovery of the protein from cell culture. The polypeptide produced by a transformed cell can be secreted or contained intracellularly depending on the sequence and/or the vector used. As will be understood by those of skill in the art, expression vectors containing polynucleotides which encode phospholipase A2-like enzyme polypeptides can be designed to contain signal sequences which direct secretion of soluble phospholipase A2-like enzyme polypeptides through a prokaryotic or eukaryotic cell membrane or which direct the membrane insertion of membrane-bound phospholipase A2-like enzyme polypeptide.

As discussed above, other constructions can be used to join a sequence encoding a phospholipase A2-like enzyme polypeptide to a nucleotide sequence encoding a polypeptide domain which will facilitate purification of soluble proteins. Such purification facilitating domains include, but are not limited to, metal chelating peptides such as histidine-tryptophan modules that allow purification on immobilized metals, protein A domains that allow purification on immobilized immunoglobulin, and the domain utilized in the FLAGS extension/affinity purification system (Immunex Corp., Seattle, Wash.). Inclusion of cleavable linker sequences such as those specific for Factor Xa or enterokinase (Invitrogen, San Diego, CA) between the purification domain and the phospholipase A2-like enzyme polypeptide also can be used to facilitate purification. One such expression vector provides for expression of a fusion protein containing a phospholipase A2-like enzyme polypeptide and 6 histidine residues preceding a thioredoxin or an enterokinase cleavage site. The histidine residues facilitate purification by IMAC (immobilized metal ion affinity chromatography, as described in Porath *et al.*, *Prot. Exp. Purif.* 3, 263-281, 1992), while the enterokinase cleavage site provides a means for purifying the phospholipase A2-like enzyme polypeptide from the fusion protein. Vectors which

contain fusion proteins are disclosed in Kroll *et al.*, *DNA Cell Biol.* 12, 441-453, 1993.

### Chemical Synthesis

5

Sequences encoding a phospholipase A2-like enzyme polypeptide can be synthesized, in whole or in part, using chemical methods well known in the art (see Caruthers *et al.*, *Nucl. Acids Res. Symp. Ser.* 215-223, 1980; Horn *et al.* *Nucl. Acids Res. Symp. Ser.* 225-232, 1980). Alternatively, a phospholipase A2-like enzyme polypeptide itself can be produced using chemical methods to synthesize its amino acid sequence, such as by direct peptide synthesis using solid-phase techniques (Merrifield, *J. Am. Chem. Soc.* 85, 2149-2154, 1963; Roberge *et al.*, *Science* 269, 202-204, 1995). Protein synthesis can be performed using manual techniques or by automation. Automated synthesis can be achieved, for example, using Applied Biosystems 431A Peptide Synthesizer (Perkin Elmer). Optionally, fragments of phospholipase A2-like enzyme polypeptides can be separately synthesized and combined using chemical methods to produce a full-length molecule.

The newly synthesized peptide can be substantially purified by preparative high performance liquid chromatography (*e.g.*, Creighton, *PROTEINS: STRUCTURES AND MOLECULAR PRINCIPLES*, WH Freeman and Co., New York, N.Y., 1983). The composition of a synthetic phospholipase A2-like enzyme polypeptide can be confirmed by amino acid analysis or sequencing (*e.g.*, the Edman degradation procedure; *see* Creighton, *supra*). Additionally, any portion of the amino acid sequence of the phospholipase A2-like enzyme polypeptide can be altered during direct synthesis and/or combined using chemical methods with sequences from other proteins to produce a variant polypeptide or a fusion protein.

### Production of Altered Polypeptides

As will be understood by those of skill in the art, it may be advantageous to produce phospholipase A2-like enzyme polypeptide-encoding nucleotide sequences possessing non-naturally occurring codons. For example, codons preferred by a particular prokaryotic or eukaryotic host can be selected to increase the rate of protein expression or to produce an RNA transcript having desirable properties, such as a half-life which is longer than that of a transcript generated from the naturally occurring sequence.

The nucleotide sequences disclosed herein can be engineered using methods generally known in the art to alter phospholipase A2-like enzyme polypeptide-encoding sequences for a variety of reasons, including but not limited to, alterations which modify the cloning, processing, and/or expression of the polypeptide or mRNA product. DNA shuffling by random fragmentation and PCR reassembly of gene fragments and synthetic oligonucleotides can be used to engineer the nucleotide sequences. For example, site-directed mutagenesis can be used to insert new restriction sites, alter glycosylation patterns, change codon preference, produce splice variants, introduce mutations, and so forth.

### Antibodies

Any type of antibody known in the art can be generated to bind specifically to an epitope of a phospholipase A2-like enzyme polypeptide. "Antibody" as used herein includes intact immunoglobulin molecules, as well as fragments thereof, such as Fab, F(ab')<sub>2</sub>, and Fv, which are capable of binding an epitope of a phospholipase A2-like enzyme polypeptide. Typically, at least 6, 8, 10, or 12 contiguous amino acids are required to form an epitope. However, epitopes which involve non-contiguous amino acids may require more, e.g., at least 15, 25, or 50 amino acids.

An antibody which specifically binds to an epitope of a phospholipase A2-like enzyme polypeptide can be used therapeutically, as well as in immunochemical assays, such as Western blots, ELISAs, radioimmunoassays, immunohistochemical assays, immunoprecipitations, or other immunochemical assays known in the art.

5 Various immunoassays can be used to identify antibodies having the desired specificity. Numerous protocols for competitive binding or immunoradiometric assays are well known in the art. Such immunoassays typically involve the measurement of complex formation between an immunogen and an antibody which specifically binds to the immunogen.

10

Typically, an antibody which specifically binds to a phospholipase A2-like enzyme polypeptide provides a detection signal at least 5-, 10-, or 20-fold higher than a detection signal provided with other proteins when used in an immunochemical assay. Preferably, antibodies which specifically bind to phospholipase A2-like poly-  
15 peptides do not detect other proteins in immunochemical assays and can immuno-precipitate a phospholipase A2-like enzyme polypeptide from solution.

20

Human phospholipase A2-like enzyme polypeptides can be used to immunize a mammal, such as a mouse, rat, rabbit, guinea pig, monkey, or human, to produce polyclonal antibodies. If desired, a phospholipase A2-like enzyme polypeptide can be conjugated to a carrier protein, such as bovine serum albumin, thyroglobulin, and keyhole limpet hemocyanin. Depending on the host species, various adjuvants can be used to increase the immunological response. Such adjuvants include, but are not limited to, Freund's adjuvant, mineral gels (e.g., aluminum hydroxide), and surface  
25 active substances (e.g. lysolecithin, pluronic polyols, polyanions, peptides, oil emulsions, keyhole limpet hemocyanin, and dinitrophenol). Among adjuvants used in humans, BCG (*bacilli Calmette-Guerin*) and *Corynebacterium parvum* are especially useful.

30

Monoclonal antibodies which specifically bind to a phospholipase A2-like enzyme polypeptide can be prepared using any technique which provides for the production

of antibody molecules by continuous cell lines in culture. These techniques include, but are not limited to, the hybridoma technique, the human B-cell hybridoma technique, and the EBV-hybridoma technique (Kohler *et al.*, *Nature* 256, 495-497, 1985; Kozbor *et al.*, *J. Immunol. Methods* 81, 31-42, 1985; Cote *et al.*, *Proc. Natl. Acad. Sci.* 80, 2026-2030, 1983; Cole *et al.*, *Mol. Cell Biol.* 62, 109-120, 1984).

In addition, techniques developed for the production of "chimeric antibodies," the splicing of mouse antibody genes to human antibody genes to obtain a molecule with appropriate antigen specificity and biological activity, can be used (Morrison *et al.*, *Proc. Natl. Acad. Sci.* 81, 6851-6855, 1984; Neuberger *et al.*, *Nature* 312, 604-608, 1984; Takeda *et al.*, *Nature* 314, 452-454, 1985). Monoclonal and other antibodies also can be "humanized" to prevent a patient from mounting an immune response against the antibody when it is used therapeutically. Such antibodies may be sufficiently similar in sequence to human antibodies to be used directly in therapy or may require alteration of a few key residues. Sequence differences between rodent antibodies and human sequences can be minimized by replacing residues which differ from those in the human sequences by site directed mutagenesis of individual residues or by grating of entire complementarity determining regions. Alternatively, humanized antibodies can be produced using recombinant methods, as described in GB2188638B. Antibodies which specifically bind to a phospholipase A2-like enzyme polypeptide can contain antigen binding sites which are either partially or fully humanized, as disclosed in U.S. 5,565,332.

Alternatively, techniques described for the production of single chain antibodies can be adapted using methods known in the art to produce single chain antibodies which specifically bind to phospholipase A2-like enzyme polypeptides. Antibodies with related specificity, but of distinct idiotypic composition, can be generated by chain shuffling from random combinatorial immunoglobulin libraries (Burton, *Proc. Natl. Acad. Sci.* 88, 11120-23, 1991).

Single-chain antibodies also can be constructed using a DNA amplification method, such as PCR, using hybridoma cDNA as a template (Thirion *et al.*, 1996, *Eur. J. Cancer Prev.* 5, 507-11). Single-chain antibodies can be mono- or bispecific, and can be bivalent or tetravalent. Construction of tetravalent, bispecific single-chain antibodies is taught, for example, in Coloma & Morrison, 1997, *Nat. Biotechnol.* 15, 159-63. Construction of bivalent, bispecific single-chain antibodies is taught in Mallender & Voss, 1994, *J. Biol. Chem.* 269, 199-206.

10 A nucleotide sequence encoding a single-chain antibody can be constructed using manual or automated nucleotide synthesis, cloned into an expression construct using standard recombinant DNA methods, and introduced into a cell to express the coding sequence, as described below. Alternatively, single-chain antibodies can be produced directly using, for example, filamentous phage technology (Verhaar *et al.*, 1995, *Int. J. Cancer* 61, 497-501; Nicholls *et al.*, 1993, *J. Immunol. Meth.* 165, 81-15 91).

Antibodies which specifically bind to phospholipase A2-like enzyme polypeptides also can be produced by inducing *in vivo* production in the lymphocyte population or by screening immunoglobulin libraries or panels of highly specific binding reagents as disclosed in the literature (Orlandi *et al.*, *Proc. Natl. Acad. Sci.* 86, 3833-3837, 20 1989; Winter *et al.*, *Nature* 349, 293-299, 1991).

Other types of antibodies can be constructed and used therapeutically in methods of the invention. For example, chimeric antibodies can be constructed as disclosed in 25 WO 93/03151. Binding proteins which are derived from immunoglobulins and which are multivalent and multispecific, such as the "diabodies" described in WO 94/13804, also can be prepared.

Antibodies according to the invention can be purified by methods well known in the 30 art. For example, antibodies can be affinity purified by passage over a column to

which a phospholipase A2-like enzyme polypeptide is bound. The bound antibodies can then be eluted from the column using a buffer with a high salt concentration.

#### Antisense Oligonucleotides

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Antisense oligonucleotides are nucleotide sequences which are complementary to a specific DNA or RNA sequence. Once introduced into a cell, the complementary nucleotides combine with natural sequences produced by the cell to form complexes and block either transcription or translation. Preferably, an antisense oligonucleotide is at least 11 nucleotides in length, but can be at least 12, 15, 20, 25, 30, 35, 40, 45, 10 or 50 or more nucleotides long. Longer sequences also can be used. Antisense oligonucleotide molecules can be provided in a DNA construct and introduced into a cell as described above to decrease the level of phospholipase A2-like enzyme gene products in the cell.

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Antisense oligonucleotides can be deoxyribonucleotides, ribonucleotides, or a combination of both. Oligonucleotides can be synthesized manually or by an automated synthesizer, by covalently linking the 5' end of one nucleotide with the 3' end of another nucleotide with non-phosphodiester internucleotide linkages such 20 alkylphosphonates, phosphorothioates, phosphorodithioates, alkylphosphonothioates, alkylphosphonates, phosphoramidates, phosphate esters, carbamates, acetamdate, carboxymethyl esters, carbonates, and phosphate triesters. See Brown, *Meth. Mol. Biol.* 20, 1-8, 1994; Sonveaux, *Meth. Mol. Biol.* 26, 1-72, 1994; Uhlmann *et al.*, *Chem. Rev.* 90, 543-583, 1990.

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Modifications of phospholipase A2-like enzyme gene expression can be obtained by designing antisense oligonucleotides which will form duplexes to the control, 5', or regulatory regions of the phospholipase A2-like enzyme gene. Oligonucleotides derived from the transcription initiation site, *e.g.*, between positions -10 and +10 30 from the start site, are preferred. Similarly, inhibition can be achieved using "triple helix" base-pairing methodology. Triple helix pairing is useful because it causes



inhibition of the ability of the double helix to open sufficiently for the binding of polymerases, transcription factors, or chaperons. Therapeutic advances using triplex DNA have been described in the literature (e.g., Gee *et al.*, in Huber & Carr, MOLECULAR AND IMMUNOLOGIC APPROACHES, Futura Publishing Co., Mt. Kisco, N.Y., 1994). An antisense oligonucleotide also can be designed to block translation of mRNA by preventing the transcript from binding to ribosomes.

Precise complementarity is not required for successful complex formation between an antisense oligonucleotide and the complementary sequence of a phospholipase A2-like enzyme polynucleotide. Antisense oligonucleotides which comprise, for example, 2, 3, 4, or 5 or more stretches of contiguous nucleotides which are precisely complementary to a phospholipase A2-like enzyme polynucleotide, each separated by a stretch of contiguous nucleotides which are not complementary to adjacent phospholipase A2-like enzyme nucleotides, can provide sufficient targeting specificity for phospholipase A2-like enzyme mRNA. Preferably, each stretch of complementary contiguous nucleotides is at least 4, 5, 6, 7, or 8 or more nucleotides in length. Non-complementary intervening sequences are preferably 1, 2, 3, or 4 nucleotides in length. One skilled in the art can easily use the calculated melting point of an antisense-sense pair to determine the degree of mismatching which will be tolerated between a particular antisense oligonucleotide and a particular phospholipase A2-like enzyme polynucleotide sequence.

Antisense oligonucleotides can be modified without affecting their ability to hybridize to a phospholipase A2-like enzyme polynucleotide. These modifications can be internal or at one or both ends of the antisense molecule. For example, internucleoside phosphate linkages can be modified by adding cholesteryl or diamine moieties with varying numbers of carbon residues between the amino groups and terminal ribose. Modified bases and/or sugars, such as arabinose instead of ribose, or a 3', 5'-substituted oligonucleotide in which the 3' hydroxyl group or the 5' phosphate group are substituted, also can be employed in a modified antisense oligonucleotide. These modified oligonucleotides can be prepared by methods well

known in the art. See, e.g., Agrawal *et al.*, *Trends Biotechnol.* 10, 152-158, 1992; Uhlmann *et al.*, *Chem. Rev.* 90, 543-584, 1990; Uhlmann *et al.*, *Tetrahedron. Lett.* 215, 3539-3542, 1987.

5     Ribozymes

Ribozymes are RNA molecules with catalytic activity. See, e.g., Cech, *Science* 236, 1532-1539; 1987; Cech, *Ann. Rev. Biochem.* 59, 543-568; 1990, Cech, *Curr. Opin. Struct. Biol.* 2, 605-609; 1992, Couture & Stinchcomb, *Trends Genet.* 12, 510-515, 10     1996. Ribozymes can be used to inhibit gene function by cleaving an RNA sequence, as is known in the art (e.g., Haseloff *et al.*, U.S. Patent 5,641,673). The mechanism of ribozyme action involves sequence-specific hybridization of the ribozyme molecule to complementary target RNA, followed by endonucleolytic cleavage. Examples include engineered hammerhead motif ribozyme molecules that can 15     specifically and efficiently catalyze endonucleolytic cleavage of specific nucleotide sequences.

The coding sequence of a phospholipase A2-like enzyme polynucleotide can be used to generate ribozymes which will specifically bind to mRNA transcribed from the 20     phospholipase A2-like enzyme polynucleotide. Methods of designing and constructing ribozymes which can cleave other RNA molecules in trans in a highly sequence specific manner have been developed and described in the art (see Haseloff *et al. Nature* 334, 585-591, 1988). For example, the cleavage activity of ribozymes can be targeted to specific RNAs by engineering a discrete "hybridization" region 25     into the ribozyme. The hybridization region contains a sequence complementary to the target RNA and thus specifically hybridizes with the target (see, for example, Gerlach *et al.*, EP 321,201).

Specific ribozyme cleavage sites within a phospholipase A2-like enzyme RNA target 30     can be identified by scanning the target molecule for ribozyme cleavage sites which include the following sequences: GUA, GUU, and GUC. Once identified, short

RNA sequences of between 15 and 20 ribonucleotides corresponding to the region of the target RNA containing the cleavage site can be evaluated for secondary structural features which may render the target inoperable. Suitability of candidate phospholipase A2-like enzyme RNA targets also can be evaluated by testing accessibility to hybridization with complementary oligonucleotides using ribonuclease protection assays. Longer complementary sequences can be used to increase the affinity of the hybridization sequence for the target. The hybridizing and cleavage regions of the ribozyme can be integrally related such that upon hybridizing to the target RNA through the complementary regions, the catalytic region of the ribozyme can cleave the target.

Ribozymes can be introduced into cells as part of a DNA construct. Mechanical methods, such as microinjection, liposome-mediated transfection, electroporation, or calcium phosphate precipitation, can be used to introduce a ribozyme-containing DNA construct into cells in which it is desired to decrease phospholipase A2-like enzyme expression. Alternatively, if it is desired that the cells stably retain the DNA construct, the construct can be supplied on a plasmid and maintained as a separate element or integrated into the genome of the cells, as is known in the art. A ribozyme-encoding DNA construct can include transcriptional regulatory elements, such as a promoter element, an enhancer or UAS element, and a transcriptional terminator signal, for controlling transcription of ribozymes in the cells.

As taught in Haseloff *et al.*, U.S. Patent 5,641,673, ribozymes can be engineered so that ribozyme expression will occur in response to factors which induce expression of a target gene. Ribozymes also can be engineered to provide an additional level of regulation, so that destruction of mRNA occurs only when both a ribozyme and a target gene are induced in the cells.

Differentially Expressed Genes

Described herein are methods for the identification of genes whose products interact with human phospholipase A2-like enzyme. Such genes may represent genes which are differentially expressed in disorders including, but not limited to, asthma, cancer, inflammation, CNS disorders, cardiovascular disorders, chronic obstructive pulmonary disease, diabetes, and obesity. Further, such genes may represent genes which are differentially regulated in response to manipulations relevant to the progression or treatment of such diseases. Additionally, such genes may have a temporally modulated expression, increased or decreased at different stages of tissue or organism development. A differentially expressed gene may also have its expression modulated under control versus experimental conditions. In addition, the human phospholipase A2-like enzyme gene or gene product may itself be tested for differential expression.

The degree to which expression differs in a normal versus a diseased state need only be large enough to be visualized via standard characterization techniques such as differential display techniques. Other such standard characterization techniques by which expression differences may be visualized include but are not limited to, quantitative RT (reverse transcriptase), PCR, and Northern analysis.

Identification of Differentially Expressed Genes

To identify differentially expressed genes total RNA or, preferably, mRNA is isolated from tissues of interest. For example, RNA samples are obtained from tissues of experimental subjects and from corresponding tissues of control subjects. Any RNA isolation technique which does not select against the isolation of mRNA may be utilized for the purification of such RNA samples. See, for example, Ausubel *et al.*, ed., CURRENT PROTOCOLS IN MOLECULAR BIOLOGY, John Wiley & Sons, Inc. New York, 1987-1993. Large numbers of tissue samples may readily be processed

using techniques well known to those of skill in the art, such as, for example, the single-step RNA isolation process of Chomczynski, U.S. Patent 4,843,155.

5 Transcripts within the collected RNA samples which represent RNA produced by differentially expressed genes are identified by methods well known to those of skill in the art. They include, for example, differential screening (Tedder *et al.*, *Proc. Natl. Acad. Sci. U.S.A.* 85, 208-12, 1988), subtractive hybridization (Hedrick *et al.*, *Nature* 308, 149-53; Lee *et al.*, *Proc. Natl. Acad. Sci. U.S.A.* 88, 2825, 1984), differential display (Liang & Pardee, *Science* 257, 967-71, 1992; U.S. Patent 10 5,262,311), and microarrays.

The differential expression information may itself suggest relevant methods for the treatment of disorders involving the human phospholipase A2-like enzyme. For example, treatment may include a modulation of expression of the differentially expressed genes and/or the gene encoding the human phospholipase A2-like enzyme. 15 The differential expression information may indicate whether the expression or activity of the differentially expressed gene or gene product or the human phospholipase A2-like enzyme gene or gene product are up-regulated or down-regulated.

#### 20 Screening Methods

The invention provides assays for screening test compounds which bind to or modulate the activity of a phospholipase A2-like enzyme polypeptide or a phospholipase A2-like enzyme polynucleotide. A test compound preferably binds to a 25 phospholipase A2-like enzyme polypeptide or polynucleotide. More preferably, a test compound decreases or increases phospholipase A2-like by at least about 10, preferably about 50, more preferably about 75, 90, or 100% relative to the absence of the test compound.

Test Compounds

Test compounds can be pharmacologic agents already known in the art or can be compounds previously unknown to have any pharmacological activity. The compounds can be naturally occurring or designed in the laboratory. They can be isolated from microorganisms, animals, or plants, and can be produced recombinantly, or synthesized by chemical methods known in the art. If desired, test compounds can be obtained using any of the numerous combinatorial library methods known in the art, including but not limited to, biological libraries, spatially addressable parallel solid phase or solution phase libraries, synthetic library methods requiring deconvolution, the "one-bead one-compound" library method, and synthetic library methods using affinity chromatography selection. The biological library approach is limited to polypeptide libraries, while the other four approaches are applicable to polypeptide, non-peptide oligomer, or small molecule libraries of compounds. See Lam, *Anticancer Drug Des.* 12, 145, 1997.

Methods for the synthesis of molecular libraries are well known in the art (see, for example, DeWitt *et al.*, *Proc. Natl. Acad. Sci. U.S.A.* 90, 6909, 1993; Erb *et al.*, *Proc. Natl. Acad. Sci. U.S.A.* 91, 11422, 1994; Zuckermann *et al.*, *J. Med. Chem.* 37, 2678, 1994; Cho *et al.*, *Science* 261, 1303, 1993; Carell *et al.*, *Angew. Chem. Int. Ed. Engl.* 33, 2059, 1994; Carell *et al.*, *Angew. Chem. Int. Ed. Engl.* 33, 2061; Gallop *et al.*, *J. Med. Chem.* 37, 1233, 1994). Libraries of compounds can be presented in solution (see, e.g., Houghten, *BioTechniques* 13, 412-421, 1992), or on beads (Lam, *Nature* 354, 82-84, 1991), chips (Fodor, *Nature* 364, 555-556, 1993), bacteria or spores (Ladner, U.S. Patent 5,223,409), plasmids (Cull *et al.*, *Proc. Natl. Acad. Sci. U.S.A.* 89, 1865-1869, 1992), or phage (Scott & Smith, *Science* 249, 386-390, 1990; Devlin, *Science* 249, 404-406, 1990); Cwirla *et al.*, *Proc. Natl. Acad. Sci.* 97, 6378-6382, 1990; Felici, *J. Mol. Biol.* 222, 301-310, 1991; and Ladner, U.S. Patent 5,223,409).

High Throughput Screening

Test compounds can be screened for the ability to bind to phospholipase A2-like enzyme polypeptides or polynucleotides or to affect phospholipase A2-like enzyme activity or phospholipase A2-like enzyme gene expression using high throughput screening. Using high throughput screening, many discrete compounds can be tested in parallel so that large numbers of test compounds can be quickly screened. The most widely established techniques utilize 96-well microtiter plates. The wells of the microtiter plates typically require assay volumes that range from 50 to 500  $\mu$ l. In addition to the plates, many instruments, materials, pipettors, robotics, plate washers, and plate readers are commercially available to fit the 96-well format.

Alternatively, "free format assays," or assays that have no physical barrier between samples, can be used. For example, an assay using pigment cells (melanocytes) in a simple homogeneous assay for combinatorial peptide libraries is described by Jayawickreme *et al.*, *Proc. Natl. Acad. Sci. U.S.A.* 19, 1614-18 (1994). The cells are placed under agarose in petri dishes, then beads that carry combinatorial compounds are placed on the surface of the agarose. The combinatorial compounds are partially released the compounds from the beads. Active compounds can be visualized as dark pigment areas because, as the compounds diffuse locally into the gel matrix, the active compounds cause the cells to change colors.

Another example of a free format assay is described by Chelsky, "Strategies for Screening Combinatorial Libraries: Novel and Traditional Approaches," reported at the First Annual Conference of The Society for Biomolecular Screening in Philadelphia, Pa. (Nov. 7-10, 1995). Chelsky placed a simple homogenous enzyme assay for carbonic anhydrase inside an agarose gel such that the enzyme in the gel would cause a color change throughout the gel. Thereafter, beads carrying combinatorial compounds via a photolinker were placed inside the gel and the compounds were partially released by UV-light. Compounds that inhibited the enzyme were observed as local zones of inhibition having less color change.

Yet another example is described by Salmon *et al.*, *Molecular Diversity* 2, 57-63 (1996). In this example, combinatorial libraries were screened for compounds that had cytotoxic effects on cancer cells growing in agar.

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Another high throughput screening method is described in Beutel *et al.*, U.S. Patent 5,976,813. In this method, test samples are placed in a porous matrix. One or more assay components are then placed within, on top of, or at the bottom of a matrix such as a gel, a plastic sheet, a filter, or other form of easily manipulated solid support. When samples are introduced to the porous matrix they diffuse sufficiently slowly, such that the assays can be performed without the test samples running together.

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#### Binding Assays

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For binding assays, the test compound is preferably a small molecule which binds to and occupies, for example, the active site of the phospholipase A2-like enzyme polypeptide, such that normal biological activity is prevented. Examples of such small molecules include, but are not limited to, small peptides or peptide-like molecules.

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In binding assays, either the test compound or the phospholipase A2-like enzyme polypeptide can comprise a detectable label, such as a fluorescent, radioisotopic, chemiluminescent, or enzymatic label, such as horseradish peroxidase, alkaline phosphatase, or luciferase. Detection of a test compound which is bound to the phospholipase A2-like enzyme polypeptide can then be accomplished, for example, by direct counting of radioemmission, by scintillation counting, or by determining conversion of an appropriate substrate to a detectable product.

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Alternatively, binding of a test compound to a phospholipase A2-like enzyme polypeptide can be determined without labeling either of the interactants. For example, a microphysiometer can be used to detect binding of a test compound with

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a phospholipase A2-like enzyme polypeptide. A microphysiometer (e.g., Cytosensor™) is an analytical instrument that measures the rate at which a cell acidifies its environment using a light-addressable potentiometric sensor (LAPS). Changes in this acidification rate can be used as an indicator of the interaction  
5 between a test compound and a phospholipase A2-like enzyme polypeptide (McConnell *et al.*, *Science* 257, 1906-1912, 1992).

Determining the ability of a test compound to bind to a phospholipase A2-like enzyme polypeptide also can be accomplished using a technology such as real-time  
10 Bimolecular Interaction Analysis (BIA) (Sjolander & Urbaniczky, *Anal. Chem.* 63, 2338-2345, 1991, and Szabo *et al.*, *Curr. Opin. Struct. Biol.* 5, 699-705, 1995). BIA is a technology for studying biospecific interactions in real time, without labeling any of the interactants (e.g., BIAcore™). Changes in the optical phenomenon surface plasmon resonance (SPR) can be used as an indication of real-time reactions between  
15 biological molecules.

In yet another aspect of the invention, a phospholipase A2-like enzyme polypeptide can be used as a "bait protein" in a two-hybrid assay or three-hybrid assay (see, e.g., U.S. Patent 5,283,317; Zervos *et al.*, *Cell* 72, 223-232, 1993; Madura *et al.*, *J. Biol.*  
20 *Chem.* 268, 12046-12054, 1993; Bartel *et al.*, *BioTechniques* 14, 920-924, 1993; Iwabuchi *et al.*, *Oncogene* 8, 1693-1696, 1993; and Brent W094/10300), to identify other proteins which bind to or interact with the phospholipase A2-like enzyme polypeptide and modulate its activity.

The two-hybrid system is based on the modular nature of most transcription factors, which consist of separable DNA-binding and activation domains. Briefly, the assay utilizes two different DNA constructs. For example, in one construct, polynucleotide encoding a phospholipase A2-like enzyme polypeptide can be fused to a polynucleotide encoding the DNA binding domain of a known transcription factor  
25 (e.g., GAL-4). In the other construct a DNA sequence that encodes an unidentified protein ("prey" or "sample") can be fused to a polynucleotide that codes for the  
30

activation domain of the known transcription factor. If the "bait" and the "prey" proteins are able to interact *in vivo* to form a protein-dependent complex, the DNA-binding and activation domains of the transcription factor are brought into close proximity. This proximity allows transcription of a reporter gene (*e.g.*, LacZ), which is operably linked to a transcriptional regulatory site responsive to the transcription factor. Expression of the reporter gene can be detected, and cell colonies containing the functional transcription factor can be isolated and used to obtain the DNA sequence encoding the protein which interacts with the phospholipase A2-like enzyme polypeptide.

It may be desirable to immobilize either the phospholipase A2-like enzyme polypeptide (or polynucleotide) or the test compound to facilitate separation of bound from unbound forms of one or both of the interactants, as well as to accommodate automation of the assay. Thus, either the phospholipase A2-like enzyme polypeptide (or polynucleotide) or the test compound can be bound to a solid support. Suitable solid supports include, but are not limited to, glass or plastic slides, tissue culture plates, microtiter wells, tubes, silicon chips, or particles such as beads (including, but not limited to, latex, polystyrene, or glass beads). Any method known in the art can be used to attach the enzyme polypeptide (or polynucleotide) or test compound to a solid support, including use of covalent and non-covalent linkages, passive absorption, or pairs of binding moieties attached respectively to the polypeptide (or polynucleotide) or test compound and the solid support. Test compounds are preferably bound to the solid support in an array, so that the location of individual test compounds can be tracked. Binding of a test compound to a phospholipase A2-like enzyme polypeptide (or polynucleotide) can be accomplished in any vessel suitable for containing the reactants. Examples of such vessels include microtiter plates, test tubes, and microcentrifuge tubes.

In one embodiment, the phospholipase A2-like enzyme polypeptide is a fusion protein comprising a domain that allows the phospholipase A2-like enzyme polypeptide to be bound to a solid support. For example, glutathione-S-transferase fusion

proteins can be adsorbed onto glutathione sepharose beads (Sigma Chemical, St. Louis, Mo.) or glutathione derivatized microtiter plates, which are then combined with the test compound or the test compound and the non-adsorbed phospholipase A2-like enzyme polypeptide; the mixture is then incubated under conditions conducive to complex formation (e.g., at physiological conditions for salt and pH). Following incubation, the beads or microtiter plate wells are washed to remove any unbound components. Binding of the interactants can be determined either directly or indirectly, as described above. Alternatively, the complexes can be dissociated from the solid support before binding is determined.

Other techniques for immobilizing proteins or polynucleotides on a solid support also can be used in the screening assays of the invention. For example, either a phospholipase A2-like enzyme polypeptide (or polynucleotide) or a test compound can be immobilized utilizing conjugation of biotin and streptavidin. Biotinylated phospholipase A2-like enzyme polypeptides (or polynucleotides) or test compounds can be prepared from biotin-NHS(N-hydroxysuccinimide) using techniques well known in the art (e.g., biotinylation kit, Pierce Chemicals, Rockford, Ill.) and immobilized in the wells of streptavidin-coated 96 well plates (Pierce Chemical). Alternatively, antibodies which specifically bind to a phospholipase A2-like enzyme polypeptide, polynucleotide, or a test compound, but which do not interfere with a desired binding site, such as the active site of the phospholipase A2-like enzyme polypeptide, can be derivatized to the wells of the plate. Unbound target or protein can be trapped in the wells by antibody conjugation.

Methods for detecting such complexes, in addition to those described above for the GST-immobilized complexes, include immunodetection of complexes using antibodies which specifically bind to the phospholipase A2-like enzyme polypeptide or test compound, enzyme-linked assays which rely on detecting an activity of the phospholipase A2-like enzyme polypeptide, and SDS gel electrophoresis under non-reducing conditions.

Screening for test compounds which bind to a phospholipase A2-like enzyme polypeptide or polynucleotide also can be carried out in an intact cell. Any cell which comprises a phospholipase A2-like enzyme polypeptide or polynucleotide can be used in a cell-based assay system. A phospholipase A2-like enzyme polynucleo-  
5 tide can be naturally occurring in the cell or can be introduced using techniques such as those described above. Binding of the test compound to a phospholipase A2-like enzyme polypeptide or polynucleotide is determined as described above.

#### Enzyme Assays

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Test compounds can be tested for the ability to increase or decrease the phospholipase A2 activity of a human phospholipase A2-like enzyme polypeptide. phospholipase A2 activity can be measured, for example, as described in the specific examples, below.

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Enzyme assays can be carried out after contacting either a purified phospholipase A2-like enzyme polypeptide, a cell membrane preparation, or an intact cell with a test compound. A test compound which decreases a phospholipase A2 activity of a phospholipase A2-like enzyme polypeptide by at least about 10, preferably about 50,  
20 more preferably about 75, 90, or 100% is identified as a potential therapeutic agent for decreasing phospholipase A2-like enzyme activity. A test compound which increases a phospholipase A2 activity of a human phospholipase A2-like enzyme polypeptide by at least about 10, preferably about 50, more preferably about 75, 90, or 100% is identified as a potential therapeutic agent for increasing human  
25 phospholipase A2-like enzyme activity.

#### Gene Expression

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In another embodiment, test compounds which increase or decrease phospholipase A2-like enzyme gene expression are identified. A phospholipase A2-like enzyme polynucleotide is contacted with a test compound, and the expression of an RNA or

polypeptide product of the phospholipase A2-like enzyme polynucleotide is determined. The level of expression of appropriate mRNA or polypeptide in the presence of the test compound is compared to the level of expression of mRNA or polypeptide in the absence of the test compound. The test compound can then be  
5 identified as a modulator of expression based on this comparison. For example, when expression of mRNA or polypeptide is greater in the presence of the test compound than in its absence, the test compound is identified as a stimulator or enhancer of the mRNA or polypeptide expression. Alternatively, when expression of the mRNA or polypeptide is less in the presence of the test compound than in its  
10 absence, the test compound is identified as an inhibitor of the mRNA or polypeptide expression.

The level of phospholipase A2-like enzyme mRNA or polypeptide expression in the cells can be determined by methods well known in the art for detecting mRNA or  
15 polypeptide. Either qualitative or quantitative methods can be used. The presence of polypeptide products of a phospholipase A2-like enzyme polynucleotide can be determined, for example, using a variety of techniques known in the art, including immunochemical methods such as radioimmunoassay, Western blotting, and immunohistochemistry. Alternatively, polypeptide synthesis can be determined *in*  
20 *vivo*, in a cell culture, or in an *in vitro* translation system by detecting incorporation of labeled amino acids into a phospholipase A2-like enzyme polypeptide.

Such screening can be carried out either in a cell-free assay system or in an intact cell. Any cell which expresses a phospholipase A2-like enzyme polynucleotide can  
25 be used in a cell-based assay system. The phospholipase A2-like enzyme polynucleotide can be naturally occurring in the cell or can be introduced using techniques such as those described above. Either a primary culture or an established cell line, such as CHO or human embryonic kidney 293 cells, can be used.

Pharmaceutical Compositions

The invention also provides pharmaceutical compositions which can be administered to a patient to achieve a therapeutic effect. Pharmaceutical compositions of the invention can comprise, for example, a phospholipase A2-like enzyme polypeptide, phospholipase A2-like enzyme polynucleotide, ribozymes or antisense oligonucleotides, antibodies which specifically bind to a phospholipase A2-like enzyme polypeptide, or mimetics, activators, or inhibitors of a phospholipase A2-like enzyme polypeptide activity. The compositions can be administered alone or in combination with at least one other agent, such as stabilizing compound, which can be administered in any sterile, biocompatible pharmaceutical carrier, including, but not limited to, saline, buffered saline, dextrose, and water. The compositions can be administered to a patient alone, or in combination with other agents, drugs or hormones.

In addition to the active ingredients, these pharmaceutical compositions can contain suitable pharmaceutically-acceptable carriers comprising excipients and auxiliaries which facilitate processing of the active compounds into preparations which can be used pharmaceutically. Pharmaceutical compositions of the invention can be administered by any number of routes including, but not limited to, oral, intravenous, intramuscular, intra-arterial, intramedullary, intrathecal, intraventricular, transdermal, subcutaneous, intraperitoneal, intranasal, parenteral, topical, sublingual, or rectal means. Pharmaceutical compositions for oral administration can be formulated using pharmaceutically acceptable carriers well known in the art in dosages suitable for oral administration. Such carriers enable the pharmaceutical compositions to be formulated as tablets, pills, dragees, capsules, liquids, gels, syrups, slurries, suspensions, and the like, for ingestion by the patient.

Pharmaceutical preparations for oral use can be obtained through combination of active compounds with solid excipient, optionally grinding a resulting mixture, and processing the mixture of granules, after adding suitable auxiliaries, if desired, to

obtain tablets or dragee cores. Suitable excipients are carbohydrate or protein fillers, such as sugars, including lactose, sucrose, mannitol, or sorbitol; starch from corn, wheat, rice, potato, or other plants; cellulose, such as methyl cellulose, hydroxypropylmethyl-cellulose, or sodium carboxymethylcellulose; gums including arabic and tragacanth; and proteins such as gelatin and collagen. If desired, disintegrating or solubilizing agents can be added, such as the cross-linked polyvinyl pyrrolidone, agar, alginic acid, or a salt thereof, such as sodium alginate.

Dragee cores can be used in conjunction with suitable coatings, such as concentrated sugar solutions, which also can contain gum arabic, talc, polyvinylpyrrolidone, carbopol gel, polyethylene glycol, and/or titanium dioxide, lacquer solutions, and suitable organic solvents or solvent mixtures. Dyestuffs or pigments can be added to the tablets or dragee coatings for product identification or to characterize the quantity of active compound, *i.e.*, dosage.

Pharmaceutical preparations which can be used orally include push-fit capsules made of gelatin, as well as soft, sealed capsules made of gelatin and a coating, such as glycerol or sorbitol. Push-fit capsules can contain active ingredients mixed with a filler or binders, such as lactose or starches, lubricants, such as talc or magnesium stearate, and, optionally, stabilizers. In soft capsules, the active compounds can be dissolved or suspended in suitable liquids, such as fatty oils, liquid, or liquid polyethylene glycol with or without stabilizers.

Pharmaceutical formulations suitable for parenteral administration can be formulated in aqueous solutions, preferably in physiologically compatible buffers such as Hanks' solution, Ringer's solution, or physiologically buffered saline. Aqueous injection suspensions can contain substances which increase the viscosity of the suspension, such as sodium carboxymethyl cellulose, sorbitol, or dextran. Additionally, suspensions of the active compounds can be prepared as appropriate oily injection suspensions. Suitable lipophilic solvents or vehicles include fatty oils such as sesame oil, or synthetic fatty acid esters, such as ethyl oleate or triglycerides,

or liposomes. Non-lipid polycationic amino polymers also can be used for delivery. Optionally, the suspension also can contain suitable stabilizers or agents which increase the solubility of the compounds to allow for the preparation of highly concentrated solutions. For topical or nasal administration, penetrants appropriate to the particular barrier to be permeated are used in the formulation. Such penetrants are generally known in the art.

The pharmaceutical compositions of the present invention can be manufactured in a manner that is known in the art, e.g., by means of conventional mixing, dissolving, granulating, dragee-making, levigating, emulsifying, encapsulating, entrapping, or lyophilizing processes. The pharmaceutical composition can be provided as a salt and can be formed with many acids, including but not limited to, hydrochloric, sulfuric, acetic, lactic, tartaric, malic, succinic, etc. Salts tend to be more soluble in aqueous or other protonic solvents than are the corresponding free base forms. In other cases, the preferred preparation can be a lyophilized powder which can contain any or all of the following: 1-50 mM histidine, 0.1%-2% sucrose, and 2-7% mannitol, at a pH range of 4.5 to 5.5, that is combined with buffer prior to use.

Further details on techniques for formulation and administration can be found in the latest edition of REMINGTON'S PHARMACEUTICAL SCIENCES (Maack Publishing Co., Easton, Pa.). After pharmaceutical compositions have been prepared, they can be placed in an appropriate container and labeled for treatment of an indicated condition. Such labeling would include amount, frequency, and method of administration.

#### Therapeutic Indications and Methods

Allergy, anaphylaxis, asthma and inflammation. Allergy is a complex process in which environmental antigens induce clinically adverse reactions. The inducing antigens, called allergens, typically elicit a specific IgE response and, although in most cases the allergens themselves have little or no intrinsic toxicity, they induce



pathology when the IgE response in turn elicits an IgE-dependent or T cell-dependent hypersensitivity reaction. Hypersensitivity reactions can be local or systemic and typically occur within minutes of allergen exposure in individuals who have previously been sensitized to an allergen. The hypersensitivity reaction of allergy  
5 develops when the allergen is recognized by IgE antibodies bound to specific receptors on the surface of effector cells, such as mast cells, basophils, or eosinophils, which causes the activation of the effector cells and the release of mediators that produce the acute signs and symptoms of the reactions. Allergic diseases include asthma, allergic rhinitis (hay fever), atopic dermatitis, and  
10 anaphylaxis.

Asthma is thought to arise as a result of interactions between multiple genetic and environmental factors and is characterized by three major features: 1) intermittent and reversible airway obstruction caused by bronchoconstriction, increased mucus  
15 production, and thickening of the walls of the airways that leads to a narrowing of the airways, 2) airway hyperresponsiveness caused by a decreased control of airway caliber, and 3) airway inflammation. Certain cells are critical to the inflammatory reaction of asthma and they include T cells and antigen presenting cells, B cells that produce IgE, and mast cells, basophils, eosinophils, and other cells that bind IgE.  
20 These effector cells accumulate at the site of allergic reaction in the airways and release toxic products that contribute to the acute pathology and eventually to the tissue destruction related to the disorder. Other resident cells, such as smooth muscle cells, lung epithelial cells, mucus-producing cells, and nerve cells may also be abnormal in individuals with asthma and may contribute to the pathology. While the  
25 airway obstruction of asthma, presenting clinically as an intermittent wheeze and shortness of breath, is generally the most pressing symptom of the disease requiring immediate treatment, the inflammation and tissue destruction associated with the disease can lead to irreversible changes that eventually make asthma a chronic disabling disorder requiring long-term management.

Despite recent important advances in our understanding of the pathophysiology of asthma, the disease appears to be increasing in prevalence and severity (Gergen and Weiss, *Am. Rev. Respir. Dis.* 146, 823-24, 1992). It is estimated that 30-40% of the population suffer with atopic allergy, and 15% of children and 5% of adults in the population suffer from asthma (Gergen and Weiss, 1992). Thus, an enormous burden is placed on our health care resources. However, both diagnosis and treatment of asthma are difficult. The severity of lung tissue inflammation is not easy to measure and the symptoms of the disease are often indistinguishable from those of respiratory infections, chronic respiratory inflammatory disorders, allergic rhinitis, or other respiratory disorders. Often, the inciting allergen cannot be determined, making removal of the causative environmental agent difficult. Current pharmacological treatments suffer their own set of disadvantages. Commonly used therapeutic agents, such as beta agonists, can act as symptom relievers to transiently improve pulmonary function, but do not affect the underlying inflammation. Agents that can reduce the underlying inflammation, such as anti-inflammatory steroids, can have major drawbacks that range from immunosuppression to bone loss (Goodman and Gilman's THE PHARMACOLOGIC BASIS OF THERAPEUTICS, Seventh Edition, MacMillan Publishing Company, NY, USA, 1985). In addition, many of the present therapies, such as inhaled corticosteroids, are short-lasting, inconvenient to use, and must be used often on a regular basis, in some cases for life, making failure of patients to comply with the treatment a major problem and thereby reducing their effectiveness as a treatment.

Because of the problems associated with conventional therapies, alternative treatment strategies have been evaluated. Glycophorin A (Chu and Sharom, *Cell. Immunol.* 145, 223-39, 1992), cyclosporin (Alexander *et al.*, *Lancet* 339, 324-28, 1992), and a nonapeptide fragment of IL-2 (Zav'yalov *et al.*, *Immunol. Lett.* 31, 285-88, 1992) all inhibit interleukin-2 dependent T lymphocyte proliferation; however, they are known to have many other effects. For example, cyclosporin is used as an immunosuppressant after organ transplantation. While these agents may represent alternatives to steroids in the treatment of asthmatics, they inhibit interleukin-2

dependent T lymphocyte proliferation and potentially critical immune functions associated with homeostasis. Other treatments that block the release or activity of mediators of bronchoconstriction, such as cromones or anti-leukotrienes, have recently been introduced for the treatment of mild asthma, but they are expensive and not effective in all patients and it is unclear whether they have any effect on the chronic changes associated with asthmatic inflammation. What is needed in the art is the identification of a treatment that can act in pathways critical to the development of asthma that both blocks the episodic attacks of the disorder and preferentially dampens the hyperactive allergic immune response without immunocompromising the patient.

It is now well-established that arachidonic acid (AA) is metabolized in mammals by two distinct pathways. U.S. Patent No. 5,070,207. The metabolism of arachidonic acid by cyclooxygenase enzymes results in the production of prostaglandins and thromboxanes. The physiological activity of the prostaglandins has already been amply elucidated in recent years. It is now known that prostaglandins arise from the endoperoxides PGG<sub>2</sub> and PGH<sub>2</sub> by the cyclooxygenase pathway of arachidonic acid metabolism. These endoperoxides are also the precursors of the thromboxanes (Tx) A<sub>2</sub> and B<sub>2</sub>. TxA<sub>2</sub> is a vasoconstrictor which stimulates platelet aggregation. In the normal situation, the vasoconstrictive and platelet aggregating properties of the thromboxanes are balanced by another product arising from the endoperoxides in the cyclooxygenase pathway, prostacyclin (PGI<sub>2</sub>), which is a vasodilator with platelet aggregation inhibitory activity. In the event prostacyclin synthesis is impaired and/or platelet activation is enhanced, then thrombosis and vasoconstriction is favored. The role of prostanoids in haemostasis and thrombosis are reviewed by Gryglewski, *CRC Crit. Rev. Biochem.* 7, 291, 1980, and Smith, *Am. J. Pathol.* 99, 743, 1980. Cyclooxygenase metabolites are known to participate directly in the inflammatory response. See Higgs *et al.*, *Annals of Clinical Research* 16, 287-99, 1984. This is through their vasodepressor activities, participation in pain and fever, augmentation of peptide mediator vascular permeability and edema forming properties. Finally,

various aspects of cell mediated immunity are influenced by cyclooxygenase products.

5 The other pathway of AA metabolism involves lipoxygenase enzymes and results in the production of a number of oxidative products called leukotrienes. The latter are designated by the LT nomenclature system, and the most significant products of the lipoxygenase metabolic pathway are the leukotrienes B<sub>4</sub>, C<sub>4</sub>, and D<sub>4</sub>. The substance denominated slow-reacting substance of anaphylaxis (SRS-A) has been shown to consist of a mixture of leukotrienes, with LTC<sub>4</sub> and LTD<sub>4</sub> as the primary products  
10 and having varying amounts of other leukotriene metabolites. See Bach *et al.*, *J. Immun.* 215, 115-18, 1980; *Biochem. Biophys. Res. Commun.* 93, 1121-26, 1980.

The significance of these leukotrienes is that a great deal of evidence has been accumulated showing that leukotrienes participate in inflammatory reactions, exhibit  
15 chemotactic activities, stimulate lysosomal enzyme release and act as important factors in the immediate hypersensitivity reaction. It has been shown that LTC<sub>4</sub> and LTD<sub>4</sub> are potent bronchoconstrictors of the human bronchi (Dahlen *et al.*, *Nature* 288, 484-486 (1980) and Piper, *Int. Arch. Appl. Immunol.* 76, suppl. 1, 43 (1985)0, which stimulate the release of mucus from airways *in vitro* [Marom *et al.*, *Am. Rev.*  
20 *Resp. Dis.* 126, 449 (1982)], are potent vasodilators in skin [see Bisgaard *et al.*, *Prostaglandins* 23, 797 (1982)], and produce a wheal and flare response [Camp *et al.*, *Br. J. Pharmacol.* 80, 497 (1983)]. The nonpeptide leukotriene, LTB<sub>4</sub>, is a powerful chemotactic factor for leukocytes [see A. W. Ford-Hutchinson, *J. Roy. Soc. Med.* 74, 831-833 (1981), which stimulates cell accumulation and affects vascular  
25 smooth muscle [see Bray, *Br. Med. Bull.* 39, 249 (1983)]. The activity of leukotrienes as mediators of inflammation and hypersensitivity is extensively reviewed in Bailey and Casey, *Ann. Reports Med. Chem.*, 19, 87 (1986).

Phospholipase A2 is the critical rate limiting enzyme in the arachidonic acid (AA) cascade, because it is responsible for the hydrolysis of esterified AA from the C-2  
30 position of membrane phospholipids. This reaction generates two products: (1) free

AA which is then available for subsequent metabolism by either the cyclooxygenase or lipoxygenase enzymes, and (2) lysophospholipid. When alkylarachidonoyl-glycerophosphatidylcholine is acted upon by the PLA<sub>2</sub>, the generation of platelet activating factor (PAF) is initiated; PAF is pro-inflammatory in its own right [see Wedmore *et al.*, *Br. J. Pharmacol.*, 74, 916-917 (1981)]. In this regard it may be noted that the anti-inflammatory steroids are thought to inhibit eicosanoid synthesis by inducing the synthesis of a PLA<sub>2</sub> inhibitory protein denominated macrocortin, lipomodulin or lipocortin [see Flower *et al.*, *Nature, London*, 278, 456 (1979) and Hirata *et al.*, *Proc. Natn. Acad. Sci. U.S.A.*, 77, 2533 (1980)].

As the initial step leading to subsequent conversion of AA to the various eicosanoids by the cyclooxygenase and lipoxygenase pathways, the PLA<sub>2</sub> -mediated release of AA from membrane phospholipids is a critical event in attempting to deal with the various physiological manifestations which are based on the activity of the eicosanoids and/or PAF. Thus, while PLA<sub>2</sub> has been shown to be required for platelet aggregation [Pickett *et al.*, *Biochem. J.*, 160, 405 (1976)], cardiac contraction and excitation [Geisler *et al.*, *Pharm. Res. Commun.*, 9, 117 (1977)], as well as prostaglandin synthesis [Vogt, *Adv. Prostagl. Thromb. Res.*, 3, 89 (1978)], the inhibition of PLA<sub>2</sub> is indicated in the therapeutic treatment of both PAF induced or cyclooxygenase and/or lipoxygenase pathway product-mediated physiological conditions. Thus, human phospholipase A<sub>2</sub>-like enzyme inhibitors are a rational approach to the prevention, removal or amelioration of such conditions as allergy, anaphylaxis, asthma and inflammation.

Cytosolic phospholipase A<sub>2</sub> (PLA<sub>2</sub>; EC 3.1.1.4) catalyzes the release of arachidonic acid from membrane phospholipids. Arachidonic acid in turn serves as the precursor for a wide spectrum of biologic effectors, collectively known as lipid mediators, such as lysophospholipids, prostaglandins, and leukotrienes, that are involved in hemodynamic regulation, inflammatory responses, and other cellular processes. Lipid mediators also play crucial roles in the pathogenesis of inflammatory diseases including asthma. Therefore, inhibition of PLA<sub>2</sub> activity has long been considered as

a good therapeutic target for inflammatory diseases. Attempts have been made in the past to develop known PLA2 inhibitors into pharmaceuticals; however, many of them have failed mainly due to general toxicity.

5 In a database search for PLA2G4A homologs, Pickard et al. (Pickard RT, Striffler BA, Kramer RM, Sharp JD. (1999). Molecular cloning of two new human paralogs of 85-kDa cytosolic phospholipase A2. *J. Biol. Chem.* 274(13): 8823-8831.) identified PLA2G4B, also called cPLA2- $\beta$ , and assembled its full-length cDNA using 5-prime RACE, cDNA library screening, and RT-PCR. The PLA2G4B protein  
10 contains a C2 calcium- and lipid-binding domain and shares approximately 30% sequence identity with PLA2G4A and PLA2G4C, including total conservation of 4 catalytically essential residues. Using a baculovirus system, they demonstrated calcium-dependent enzymatic activity.

15 The human phospholipase A2-like enzyme disclosed herein shows 50% identity to human cPLA2- $\beta$ . In experiments on its expression in normal human tissues, the gene appears to be specifically and highly expressed in skeletal muscle, with relatively very low, but present, expression in other tissues such as prostate, uterus, testis, and placenta (Fig. 17). Cytosolic PLA2 has been suggested to play a role in muscle cells  
20 by providing fatty acid precursors to oxygenating enzymes for the production of mediators, including 20-hydroxyeicosatetraenoic acid, that activate MAP kinase (Muthalif, M.M., Benter, I.F., Karzoun, N., Fatima, S., Harper, J., Uddin, M.R., and Malik, K.U. (1998). 20-Hydroxyeicosatetraenoic acid mediates CaM kinase II-induced MAP kinase activation in VSMC. *Proc. Natl. Acad. Sci. U.S.A.* 95, 12701-  
25 12706.). The regulation of the human phospholipase A2-like enzyme in skeletal muscle is therefore useful in the treatment of inflammatory and other diseases that involve muscle and are mediated in part by metabolites of arachidonic acid.

Cancer. Human phospholipase A2-like enzyme can be regulated to treat cancer.  
30 Cancer is a disease fundamentally caused by oncogenic cellular transformation. There are several hallmarks of transformed cells that distinguish them from their

normal counterparts and underlie the pathophysiology of cancer. These include uncontrolled cellular proliferation, unresponsiveness to normal death-inducing signals (immortalization), increased cellular motility and invasiveness, increased ability to recruit blood supply through induction of new blood vessel formation (angiogenesis), genetic instability, and dysregulated gene expression. Various combinations of these aberrant physiologies, along with the acquisition of drug-resistance frequently lead to an intractable disease state in which organ failure and patient death ultimately ensue.

10 Most standard cancer therapies target cellular proliferation and rely on the differential proliferative capacities between transformed and normal cells for their efficacy. This approach is hindered by the facts that several important normal cell types are also highly proliferative and that cancer cells frequently become resistant to these agents. Thus, the therapeutic indices for traditional anti-cancer therapies rarely  
15 exceed 2.0.

The advent of genomics-driven molecular target identification has opened up the possibility of identifying new cancer-specific targets for therapeutic intervention that will provide safer, more effective treatments for cancer patients. Thus, newly discovered tumor-associated genes and their products can be tested for their role(s) in  
20 disease and used as tools to discover and develop innovative therapies. Genes playing important roles in any of the physiological processes outlined above can be characterized as cancer targets.

25 Genes or gene fragments identified through genomics can readily be expressed in one or more heterologous expression systems to produce functional recombinant proteins. These proteins are characterized *in vitro* for their biochemical properties and then used as tools in high-throughput molecular screening programs to identify chemical modulators of their biochemical activities. Activators and/or inhibitors of target  
30 protein activity can be identified in this manner and subsequently tested in cellular and *in vivo* disease models for anti-cancer activity. Optimization of lead compounds

with iterative testing in biological models and detailed pharmacokinetic and toxicological analyses form the basis for drug development and subsequent testing in humans.

5 It is known that agents which increase phospholipase A2 activity stimulate the recruitment/activation of cells of the immune system. U.S. Patent No. 5,527,775. Based on this observation, the present invention provides methods for treating neoplastic diseases. Specifically, tumor necrosis, the killing of neoplastic cells and a reduction in the size of a neoplastic mass, can be induced in a mammal suffering  
10 from a neoplastic disease by administering an effective amount of an agent which stimulates human phospholipase A2-like enzyme activity or promotes arachidonic acid release, an indication of phospholipase A2-like enzyme activity. The stimulation of phospholipase A2-like enzyme activity results in the generation of eicosanoids, leading to the recruitment/activation of cell which promote an  
15 inflammatory response. The inflammatory response triggers the mammal's immune system to destroy the neoplastic cells. The response initiated by the treatment of the present invention results in a reduction in the severity of the neoplastic disease, a reduction of the tumor burden in the mammal, and a significant reduction in the number of neoplastic cells and neoplasm mass.

20

CNS Disorders. Phospholipases are implicated in a variety of CNS disorders. Ross *et al.*, Neuroscience. 1998 Apr;83(3):791-8; Ross *et al.*, J Neurochem. 1998 Feb;70(2):786-93; Farooqui *et al.*, Brain Res Bull. Jun;49(3):139-53, 1999; Farooqui *et al.*, Neurochem Int. Jun;30(6):517-22, 1997; 8: Farooqui *et al.*, Ann Neurol. 1988  
25 Mar;23(3):306-8. A $\beta$ -mediated neuronal cell degeneration is mediated by a biochemical cascade which requires activity of PLA2. U.S. Patent No. 5,707,821. Agents which selectively block PLA2 activity in neurons and/or glial cells and/or astrocytes or monocytes can be used to inhibit A $\beta$ -mediated neuronal degeneration, such as that which results from exposure of such cells to pathogenic forms of A $\beta$  as  
30 occurs in Alzheimer's Disease and related A $\beta$ -induced neurodegenerative conditions.



It is likely, therefore, that inhibitors of human phospholipase A2-like enzyme also can be used to inhibit neuronal degeneration resulting from A $\beta$  toxicity.

5 CNS disorders which may be treated include brain injuries, cerebrovascular diseases and their consequences, Parkinson's disease, corticobasal degeneration, motor neuron disease, dementia, including ALS, multiple sclerosis, traumatic brain injury, stroke, post-stroke, post-traumatic brain injury, and small-vessel cerebrovascular disease. Dementias, such as Alzheimer's disease, vascular dementia, dementia with Lewy bodies, frontotemporal dementia and Parkinsonism linked to chromosome 17,  
10 frontotemporal dementias, including Pick's disease, progressive nuclear palsy, corticobasal degeneration, Huntington's disease, thalamic degeneration, Creutzfeld-Jakob dementia, HIV dementia, schizophrenia with dementia, and Korsakoff's psychosis also can be treated. Similarly, it may be possible to treat cognitive-related disorders, such as mild cognitive impairment, age-associated memory impairment,  
15 age-related cognitive decline, vascular cognitive impairment, attention deficit disorders, attention deficit hyperactivity disorders, and memory disturbances in children with learning disabilities, by regulating the activity of human phospholipase A2-like enzyme.

20 Pain that is associated with CNS disorders also can be treated by regulating the activity of human phospholipase A2-like enzyme. Pain which can be treated includes that associated with central nervous system disorders, such as multiple sclerosis, spinal cord injury, sciatica, failed back surgery syndrome, traumatic brain injury, epilepsy, Parkinson's disease, post-stroke, and vascular lesions in the brain and  
25 spinal cord (*e.g.*, infarct, hemorrhage, vascular malformation). Non-central neuropathic pain includes that associated with post mastectomy pain, reflex sympathetic dystrophy (RSD), trigeminal neuralgia, radioculopathy, post-surgical pain, HIV/AIDS related pain, cancer pain, metabolic neuropathies (*e.g.*, diabetic neuropathy, vasculitic neuropathy secondary to connective tissue disease), paraneoplastic poly-  
30 neuropathy associated, for example, with carcinoma of lung, or leukemia, or lymphoma, or carcinoma of prostate, colon or stomach, trigeminal neuralgia, cranial

neuralgias, and post-herpetic neuralgia. Pain associated with cancer and cancer treatment also can be treated, as can headache pain (for example, migraine with aura, migraine without aura, and other migraine disorders), episodic and chronic tension-type headache, tension-type like headache, cluster headache, and chronic paroxysmal hemicrania.

Cardiovascular Disease. Evidence has accumulated for a potential role of PLA2 in myocardial injury to the ischemic heart. U.S. Patent No. 5,208,244; Mock *et al.*, *Lipids*. 1990 Jul;25(7):357-62; Sedlis *et al.*, *J Lab Clin Med*. 1993 Jan;121(1):111-7.; 9: Das *et al.*, *Am J Physiol*. 1986 Jul;251(1 Pt 2):H71-9. For example, it has been shown that endogenous fatty acids increase several fold in an ischemic dog heart *in vivo* and in isolated perfused ischemic rat and dog hearts. See, for example, van der Vusse *et al*, *Circ. Res.* 50, 538-46 (1982); Chien *et al*, *Circ. Res.*, 54, 313-22 (1984); Burton *et al*, *Am. J. Pathol.*, 124, 238-45 (1985). It has also been shown that lysophospholipids accumulate 2 to 3 fold in the ischemic cat heart *in vivo*, Corr. *et al*, *J. Clin. Invest.*, 83, 927-36 (1989). The accumulation of the products of phospholipid hydrolysis implies that a PLA2 may become activated in the ischemic heart.

Lysophospholipids have also been implicated as potential mediators of sudden cardiac death, Corr *et al*, "Lethal Arrhythmias Resulting from Myocardial Ischemia and Infarction", Rosen & Patti, eds., Kluwer Academic Publishers, Boston, 91-014 (1989). The addition of lysophospholipids to normoxic myocardial tissue *in vitro* induces electrophysiological alterations that are similar to those observed in the ischemic heart *in vivo*. Corr *et al*, *Circ. Res.*, 55, 135-54 (1984).

Most importantly, lysophospholipid accumulation in the ischemic dog heart *in vivo* has been correlated with the frequency of cardiac arrhythmias, Kinnaird *et al*, *Lipids*, 23, 32-35 (1988). Furthermore, it is known that the carnitine acyltransferase 1 inhibitor, 2-[5-(4-chlorophenyl)-pentyl]-oxirane-2-carboxylate (POCA), prevents the onset of ventricular fibrillation and ventricular tachycardia and inhibits the ac-

cumulation of lysophospholipids (and long-chain aoyloarnitines) in the ischemic cat heart *in vivo*. Corr et al, J. Clin. Invest., 83, 927-36 (1989).

5 Accelerated phospholipid catabolism by PLA2 has also been implicated as a cause of infarct damage in the ischemic heart. In the ischemic heart, ATP levels decrease. Treatment of rat neonatal myocytes with the glycolytic inhibitor iodoacetate lowers the levels of ATP which results in the release of arachidonic acid and morphological alterations of the myocytes, Chien et al, J. Clin. Invest., 75, 1770-80 (1985). One PLA2 inhibitor (U26,384) prevented the release of arachidonic acid, phospholipid  
10 degradation, sarcolemmal membrane defects and the release of creatine kinase that was induced by the treatment of rat neonatal myocytes with iodoacetate, Sen et al, J. Clin. Invest., 82, 1333-38 (1988).

15 Therefore, inhibition of human phospholipase A2-like enzyme activity, without inhibiting other mammalian PLA2 enzymes, to prevent the accumulation of arrhythmogenic lysophospholipids in an ischemic heart is a potential therapeutic approach for the prevention of arrhythmias, infarct damage and sudden death.

Chronic obstructive pulmonary disease. Inhibitors of human phospholipase A2-like  
20 enzyme also can be used to treat other conditions mediated by products of the oxidation of arachidonic acid, such as chronic obstructive pulmonary disease, emphysema, and acute respiratory distress syndrome. U.S. Patent No. 5,508,302. Chronic obstructive pulmonary (or airways) disease (COPD) is a condition defined physiologically as airflow obstruction that generally results from a mixture of  
25 emphysema and peripheral airway obstruction due to chronic bronchitis (Senior & Shapiro, *Pulmonary Diseases and Disorders*, 3d ed., New York, McGraw-Hill, 1998, pp. 659-681, 1998; Barnes, *Chest* 117, 10S-14S, 2000). Emphysema is characterized by destruction of alveolar walls leading to abnormal enlargement of the air spaces of the lung. Chronic bronchitis is defined clinically as the presence of chronic  
30 productive cough for three months in each of two successive years. In COPD, airflow obstruction is usually progressive and is only partially reversible. By far the

most important risk factor for development of COPD is cigarette smoking, although the disease does occur in non-smokers.

5      Chronic inflammation of the airways is a key pathological feature of COPD (Senior & Shapiro, 1998). The inflammatory cell population comprises increased numbers of macrophages, neutrophils, and CD8<sup>+</sup> lymphocytes. Inhaled irritants, such as cigarette smoke, activate macrophages which are resident in the respiratory tract, as well as epithelial cells leading to release of chemokines (e.g., interleukin-8) and other chemotactic factors. These chemotactic factors act to increase the neutro-  
10      phil/monocyte trafficking from the blood into the lung tissue and airways. Neutrophils and monocytes recruited into the airways can release a variety of potentially damaging mediators such as proteolytic enzymes and reactive oxygen species. Matrix degradation and emphysema, along with airway wall thickening, surfactant dysfunction, and mucus hypersecretion, all are potential sequelae of this inflam-  
15      matory response that lead to impaired airflow and gas exchange.

Obesity. Obesity, too, may be treated by regulating human phospholipase A2-like enzyme. Obesity and overweight are defined as an excess of body fat relative to lean body mass. An increase in caloric intake or a decrease in energy expenditure or both  
20      can bring about this imbalance leading to surplus energy being stored as fat. Obesity is associated with important medical morbidities and an increase in mortality. The causes of obesity are poorly understood and may be due to genetic factors, environmental factors or a combination of the two to cause a positive energy balance. In contrast, anorexia and cachexia are characterized by an imbalance in energy intake  
25      versus energy expenditure leading to a negative energy balance and weight loss. Agents that either increase energy expenditure and/or decrease energy intake, absorption or storage would be useful for treating obesity, overweight, and associated comorbidities. Agents that either increase energy intake and/or decrease energy expenditure or increase the amount of lean tissue would be useful for treating  
30      cachexia, anorexia and wasting disorders.

This gene, translated proteins and agents which modulate this gene or portions of the gene or its products are useful for treating obesity, overweight, anorexia, cachexia, wasting disorders, appetite suppression, appetite enhancement, increases or decreases in satiety, modulation of body weight, and/or other eating disorders such as bulimia.

5 Also this gene, translated proteins and agents which modulate this gene or portions of the gene or its products are useful for treating obesity/overweight-associated comorbidities including hypertension, type 2 diabetes, coronary artery disease, hyperlipidemia, stroke, gallbladder disease, gout, osteoarthritis, sleep apnea and respiratory problems, some types of cancer including endometrial, breast, prostate,  
10 and colon cancer, thrombotic disease, polycystic ovarian syndrome, reduced fertility, complications of pregnancy, menstrual irregularities, hirsutism, stress incontinence, and depression.

Diabetes. Diabetes mellitus is a common metabolic disorder characterized by an  
15 abnormal elevation in blood glucose, alterations in lipids and abnormalities (complications) in the cardiovascular system, eye, kidney and nervous system. Diabetes is divided into two separate diseases: type 1 diabetes (juvenile onset), which results from a loss of cells which make and secrete insulin, and type 2 diabetes (adult onset), which is caused by a defect in insulin secretion and a defect in insulin  
20 action.

Type 1 diabetes is initiated by an autoimmune reaction that attacks the insulin secreting cells (beta cells) in the pancreatic islets. Agents that prevent this reaction from occurring or that stop the reaction before destruction of the beta cells has been  
25 accomplished are potential therapies for this disease. Other agents that induce beta cell proliferation and regeneration also are potential therapies.

Type II diabetes is the most common of the two diabetic conditions (6% of the population). The defect in insulin secretion is an important cause of the diabetic  
30 condition and results from an inability of the beta cell to properly detect and respond to rises in blood glucose levels with insulin release. Therapies that increase the

response by the beta cell to glucose would offer an important new treatment for this disease.

5 The defect in insulin action in Type II diabetic subjects is another target for therapeutic intervention. Agents that increase the activity of the insulin receptor in muscle, liver, and fat will cause a decrease in blood glucose and a normalization of plasma lipids. The receptor activity can be increased by agents that directly stimulate the receptor or that increase the intracellular signals from the receptor. Other therapies can directly activate the cellular end process, *i.e.* glucose transport or various enzyme  
10 systems, to generate an insulin-like effect and therefore a produce beneficial outcome. Because overweight subjects have a greater susceptibility to Type II diabetes, any agent that reduces body weight is a possible therapy.

15 Both Type I and Type diabetes can be treated with agents that mimic insulin action or that treat diabetic complications by reducing blood glucose levels. Likewise, agents that reduces new blood vessel growth can be used to treat the eye complications that develop in both diseases.

20 This invention further pertains to the use of novel agents identified by the screening assays described above. Accordingly, it is within the scope of this invention to use a test compound identified as described herein in an appropriate animal model. For example, an agent identified as described herein (*e.g.*, a modulating agent, an antisense nucleic acid molecule, a specific antibody, ribozyme, or a phospholipase A2-like enzyme polypeptide binding molecule) can be used in an animal model to  
25 determine the efficacy, toxicity, or side effects of treatment with such an agent. Alternatively, an agent identified as described herein can be used in an animal model to determine the mechanism of action of such an agent. Furthermore, this invention pertains to uses of novel agents identified by the above-described screening assays for treatments as described herein.

A reagent which affects phospholipase A2-like enzyme activity can be administered to a human cell, either *in vitro* or *in vivo*, to reduce phospholipase A2-like enzyme activity. The reagent preferably binds to an expression product of a human phospholipase A2-like enzyme gene. If the expression product is a protein, the reagent is preferably an antibody. For treatment of human cells *ex vivo*, an antibody can be added to a preparation of stem cells which have been removed from the body. The cells can then be replaced in the same or another human body, with or without clonal propagation, as is known in the art.

In one embodiment, the reagent is delivered using a liposome. Preferably, the liposome is stable in the animal into which it has been administered for at least about 30 minutes, more preferably for at least about 1 hour, and even more preferably for at least about 24 hours. A liposome comprises a lipid composition that is capable of targeting a reagent, particularly a polynucleotide, to a particular site in an animal, such as a human. Preferably, the lipid composition of the liposome is capable of targeting to a specific organ of an animal, such as the lung, liver, spleen, heart brain, lymph nodes, and skin.

A liposome useful in the present invention comprises a lipid composition that is capable of fusing with the plasma membrane of the targeted cell to deliver its contents to the cell. Preferably, the transfection efficiency of a liposome is about 0.5  $\mu\text{g}$  of DNA per 16 nmole of liposome delivered to about  $10^6$  cells, more preferably about 1.0  $\mu\text{g}$  of DNA per 16 nmole of liposome delivered to about  $10^6$  cells, and even more preferably about 2.0  $\mu\text{g}$  of DNA per 16 nmol of liposome delivered to about  $10^6$  cells. Preferably, a liposome is between about 100 and 500 nm, more preferably between about 150 and 450 nm, and even more preferably between about 200 and 400 nm in diameter.

Suitable liposomes for use in the present invention include those liposomes standardly used in, for example, gene delivery methods known to those of skill in the art. More preferred liposomes include liposomes having a polycationic lipid

composition and/or liposomes having a cholesterol backbone conjugated to polyethylene glycol. Optionally, a liposome comprises a compound capable of targeting the liposome to a particular cell type, such as a cell-specific ligand exposed on the outer surface of the liposome.

5

Complexing a liposome with a reagent such as an antisense oligonucleotide or ribozyme can be achieved using methods which are standard in the art (see, for example, U.S. Patent 5,705,151). Preferably, from about 0.1  $\mu$ g to about 10  $\mu$ g of polynucleotide is combined with about 8 nmol of liposomes, more preferably from about 0.5  $\mu$ g to about 5  $\mu$ g of polynucleotides are combined with about 8 nmol liposomes, and even more preferably about 1.0  $\mu$ g of polynucleotides is combined with about 8 nmol liposomes.

10

In another embodiment, antibodies can be delivered to specific tissues *in vivo* using receptor-mediated targeted delivery. Receptor-mediated DNA delivery techniques are taught in, for example, Findeis *et al.* *Trends in Biotechnol.* 11, 202-05 (1993); Chiou *et al.*, GENE THERAPEUTICS: METHODS AND APPLICATIONS OF DIRECT GENE TRANSFER (J.A. Wolff, ed.) (1994); Wu & Wu, *J. Biol. Chem.* 263, 621-24 (1988); Wu *et al.*, *J. Biol. Chem.* 269, 542-46 (1994); Zenke *et al.*, *Proc. Natl. Acad. Sci. U.S.A.* 87, 3655-59 (1990); Wu *et al.*, *J. Biol. Chem.* 266, 338-42 (1991).

20

#### Determination of a Therapeutically Effective Dose

The determination of a therapeutically effective dose is well within the capability of those skilled in the art. A therapeutically effective dose refers to that amount of active ingredient which increases or decreases phospholipase A2-like enzyme activity relative to the phospholipase A2-like enzyme activity which occurs in the absence of the therapeutically effective dose.

25

For any compound, the therapeutically effective dose can be estimated initially either in cell culture assays or in animal models, usually mice, rabbits, dogs, or pigs. The

30



animal model also can be used to determine the appropriate concentration range and route of administration. Such information can then be used to determine useful doses and routes for administration in humans.

5 Therapeutic efficacy and toxicity, e.g.,  $ED_{50}$  (the dose therapeutically effective in 50% of the population) and  $LD_{50}$  (the dose lethal to 50% of the population), can be determined by standard pharmaceutical procedures in cell cultures or experimental animals. The dose ratio of toxic to therapeutic effects is the therapeutic index, and it can be expressed as the ratio,  $LD_{50}/ED_{50}$ .

10 Pharmaceutical compositions which exhibit large therapeutic indices are preferred. The data obtained from cell culture assays and animal studies is used in formulating a range of dosage for human use. The dosage contained in such compositions is preferably within a range of circulating concentrations that include the  $ED_{50}$  with  
15 little or no toxicity. The dosage varies within this range depending upon the dosage form employed, sensitivity of the patient, and the route of administration.

The exact dosage will be determined by the practitioner, in light of factors related to the subject that requires treatment. Dosage and administration are adjusted to provide  
20 sufficient levels of the active ingredient or to maintain the desired effect. Factors which can be taken into account include the severity of the disease state, general health of the subject, age, weight, and gender of the subject, diet, time and frequency of administration, drug combination(s), reaction sensitivities, and tolerance/response to therapy. Long-acting pharmaceutical compositions can be  
25 administered every 3 to 4 days, every week, or once every two weeks depending on the half-life and clearance rate of the particular formulation.

Normal dosage amounts can vary from 0.1 to 100,000 micrograms, up to a total dose of about 1 g, depending upon the route of administration. Guidance as to particular  
30 dosages and methods of delivery is provided in the literature and generally available to practitioners in the art. Those skilled in the art will employ different formulations

for nucleotides than for proteins or their inhibitors. Similarly, delivery of polynucleotides or polypeptides will be specific to particular cells, conditions, locations, etc.

5 If the reagent is a single-chain antibody, polynucleotides encoding the antibody can be constructed and introduced into a cell either *ex vivo* or *in vivo* using well-established techniques including, but not limited to, transferrin-polycation-mediated DNA transfer, transfection with naked or encapsulated nucleic acids, liposome-mediated cellular fusion, intracellular transportation of DNA-coated latex beads, 10 protoplast fusion, viral infection, electroporation, "gene gun," and DEAE- or calcium phosphate-mediated transfection.

Effective *in vivo* dosages of an antibody are in the range of about 5  $\mu$ g to about 50  $\mu$ g/kg, about 50  $\mu$ g to about 5 mg/kg, about 100  $\mu$ g to about 500  $\mu$ g/kg of patient 15 body weight, and about 200 to about 250  $\mu$ g/kg of patient body weight. For administration of polynucleotides encoding single-chain antibodies, effective *in vivo* dosages are in the range of about 100 ng to about 200 ng, 500 ng to about 50 mg, about 1  $\mu$ g to about 2 mg, about 5  $\mu$ g to about 500  $\mu$ g, and about 20  $\mu$ g to about 100  $\mu$ g of DNA.

20 If the expression product is mRNA, the reagent is preferably an antisense oligonucleotide or a ribozyme. Polynucleotides which express antisense oligonucleotides or ribozymes can be introduced into cells by a variety of methods, as described above.

25 Preferably, a reagent reduces expression of a phospholipase A2-like enzyme gene or the activity of a phospholipase A2-like enzyme polypeptide by at least about 10, preferably about 50, more preferably about 75, 90, or 100% relative to the absence of the reagent. The effectiveness of the mechanism chosen to decrease the level of 30 expression of a phospholipase A2-like enzyme gene or the activity of a phospholipase A2-like enzyme polypeptide can be assessed using methods well known in

the art, such as hybridization of nucleotide probes to phospholipase A2-like enzyme-specific mRNA, quantitative RT-PCR, immunologic detection of a phospholipase A2-like enzyme polypeptide, or measurement of phospholipase A2-like enzyme activity.

5

In any of the embodiments described above, any of the pharmaceutical compositions of the invention can be administered in combination with other appropriate therapeutic agents. Selection of the appropriate agents for use in combination therapy can be made by one of ordinary skill in the art, according to conventional pharmaceutical principles. The combination of therapeutic agents can act synergistically to effect the treatment or prevention of the various disorders described above. Using this approach, one may be able to achieve therapeutic efficacy with lower dosages of each agent, thus reducing the potential for adverse side effects.

10

Any of the therapeutic methods described above can be applied to any subject in need of such therapy, including, for example, mammals such as dogs, cats, cows, horses, rabbits, monkeys, and most preferably, humans.

#### Diagnostic Methods

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Human phospholipase A2-like enzyme also can be used in diagnostic assays for detecting diseases and abnormalities or susceptibility to diseases and abnormalities related to the presence of mutations in the nucleic acid sequences which encode the enzyme. For example, differences can be determined between the cDNA or genomic sequence encoding phospholipase A2-like enzyme in individuals afflicted with a disease and in normal individuals. If a mutation is observed in some or all of the afflicted individuals but not in normal individuals, then the mutation is likely to be the causative agent of the disease.

20

Sequence differences between a reference gene and a gene having mutations can be revealed by the direct DNA sequencing method. In addition, cloned DNA segments

25

Sequence differences between a reference gene and a gene having mutations can be revealed by the direct DNA sequencing method. In addition, cloned DNA segments

30

can be employed as probes to detect specific DNA segments. The sensitivity of this method is greatly enhanced when combined with PCR. For example, a sequencing primer can be used with a double-stranded PCR product or a single-stranded template molecule generated by a modified PCR. The sequence determination is performed  
5 by conventional procedures using radiolabeled nucleotides or by automatic sequencing procedures using fluorescent tags.

Genetic testing based on DNA sequence differences can be carried out by detection of alteration in electrophoretic mobility of DNA fragments in gels with or without  
10 denaturing agents. Small sequence deletions and insertions can be visualized, for example, by high resolution gel electrophoresis. DNA fragments of different sequences can be distinguished on denaturing formamide gradient gels in which the mobilities of different DNA fragments are retarded in the gel at different positions according to their specific melting or partial melting temperatures (*see, e.g., Myers et al., Science 230, 1242, 1985*). Sequence changes at specific locations can also be  
15 revealed by nuclease protection assays, such as RNase and S 1 protection or the chemical cleavage method (*e.g., Cotton et al., Proc. Natl. Acad. Sci. USA 85, 4397-4401, 1985*). Thus, the detection of a specific DNA sequence can be performed by methods such as hybridization, RNase protection, chemical cleavage, direct DNA  
20 sequencing or the use of restriction enzymes and Southern blotting of genomic DNA. In addition to direct methods such as gel-electrophoresis and DNA sequencing, mutations can also be detected by *in situ* analysis.

Altered levels of a phospholipase A2-like enzyme also can be detected in various  
25 tissues. Assays used to detect levels of the receptor polypeptides in a body sample, such as blood or a tissue biopsy, derived from a host are well known to those of skill in the art and include radioimmunoassays, competitive binding assays, Western blot analysis, and ELISA assays.

30 All patents and patent applications cited in this disclosure are expressly incorporated herein by reference. The above disclosure generally describes the present invention.

A more complete understanding can be obtained by reference to the following specific examples which are provided for purposes of illustration only and are not intended to limit the scope of the invention.

5     EXAMPLE 1

*Detection of phospholipase A2-like enzyme activity*

10     The polynucleotide of SEQ ID NO: 1 is inserted into the expression vector pCEV4 and the expression vector pCEV4-phospholipase A2-like enzyme polypeptide obtained is transfected into human embryonic kidney 293 cells. From these cells extracts are obtained. Human phospholipase A2-like enzyme activity is determined by an *in vitro* hydrolysis assay with vesicles containing 1-palmitoyl-2-[1-<sup>14</sup>C]oleoyl phosphatidylcholine (Sigma Chemical Co.). Human phospholipase A2-like enzyme  
15     phospholipase A2 activity is demonstrates by analysis of the cleavage products isolated from the hydrolysis reaction mixture.

Vesicles containing 1-palmitoyl-2-[1-<sup>14</sup>C]oleoyl phosphatidylcholine (Amersham Corp.) are prepared by mixing 2.0 µCi of the radiolabeled phospholipid with 12.5 mg  
20     of unlabeled 1-palmitoyl-2-oleoyl phosphatidylcholine and drying the mixture under N<sub>2</sub>. Two and a half ml of 150 mM Tris-HCl, pH 7.5, is added, and the mixture is sonicated and centrifuged. The supernatant may be stored at 4 °C. The final reaction mixture contains 0.25 ml of Hanks buffered salt solution supplemented with 2.0 mM taurochenodeoxycholate, 1.0% bovine serum albumin, 1.0 mM CaCl<sub>2</sub>, pH 7.4,  
25     150 µg of 1-palmitoyl-2-[1-<sup>14</sup>C]oleoyl phosphatidylcholine vesicles, and various amount of human phospholipase A2-like enzyme diluted in PBS. After incubation for 30 min at 37 °C, 20 µg each of lyso-phosphatidylcholine and oleic acid are added as carriers and each sample is extracted for total lipids.

30     The lipids are separated by thin layer chromatography, using a two solvent system of chloroform:methanol:acetic acid:water (65:35:8:4) until the solvent front is halfway

up the plate, the process is then continued with hexane:ether:acetic acid (86:16:1) until the solvent front is at the top of the plate. The lipid-containing areas are visualized with I2 vapor; the spots are scraped, and their radioactivity is determined by scintillation counting. The amount of radioactivity released as fatty acids will increase. The cell extracts mentioned above are added to the assay mixture while the amount of radioactivity released as lyso-phosphatidylcholine will remain low. This demonstrates that human phospholipase A2-like enzyme cleaves at the Serial No.-2 and not the Serial No.-1 position, exhibiting phospholipase A2 activity. It is shown that the polypeptide of SEQ ID NO: 2 has a phospholipase A2-like enzyme activity.

## EXAMPLE 2

### *Expression of recombinant human phospholipase A2-like enzyme*

The *Pichia pastoris* expression vector pPICZB (Invitrogen, San Diego, CA) is used to produce large quantities of recombinant human phospholipase A2-like polypeptides in yeast. The phospholipase A2-like enzyme-encoding DNA sequence is derived from SEQ ID NO:1, 3 or 8. Before insertion into vector pPICZB, the DNA sequence is modified by well known methods in such a way that it contains at its 5'-end an initiation codon and at its 3'-end an enterokinase cleavage site, a His6 reporter tag and a termination codon. Moreover, at both termini recognition sequences for restriction endonucleases are added and after digestion of the multiple cloning site of pPICZ B with the corresponding restriction enzymes the modified DNA sequence is ligated into pPICZB. This expression vector is designed for inducible expression in *Pichia pastoris*, driven by a yeast promoter. The resulting pPICZ/md-His6 vector is used to transform the yeast.

The yeast is cultivated under usual conditions in 5 liter shake flasks and the recombinantly produced protein isolated from the culture by affinity chromatography (Ni-NTA-Resin) in the presence of 8 M urea. The bound polypeptide is eluted with buffer, pH 3.5, and neutralized. Separation of the polypeptide from the His6 reporter

tag is accomplished by site-specific proteolysis using enterokinase (Invitrogen, San Diego, CA) according to manufacturer's instructions. Purified human phospholipase A2-like enzyme polypeptide is obtained.

5     EXAMPLE 3

*Identification of test compounds that bind to phospholipase A2-like enzyme polypeptides*

- 10     Purified phospholipase A2-like enzyme polypeptides comprising a glutathione-S-transferase protein and absorbed onto glutathione-derivatized wells of 96-well microtiter plates are contacted with test compounds from a small molecule library at pH 7.0 in a physiological buffer solution. Human phospholipase A2-like enzyme polypeptides comprise the amino acid sequences shown in SEQ ID NOS:2 and 4.
- 15     The test compounds comprise a fluorescent tag. The samples are incubated for 5 minutes to one hour. Control samples are incubated in the absence of a test compound.

- The buffer solution containing the test compounds is washed from the wells.
- 20     Binding of a test compound to a phospholipase A2-like enzyme polypeptide is detected by fluorescence measurements of the contents of the wells. A test compound which increases the fluorescence in a well by at least 15% relative to fluorescence of a well in which a test compound is not incubated is identified as a compound which binds to a phospholipase A2-like enzyme polypeptide.

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EXAMPLE 4

*Identification of a test compound which decreases phospholipase A2-like enzyme gene expression*

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A test compound is administered to a culture of human cells transfected with a phospholipase A2-like enzyme expression construct and incubated at 37°C for 10 to 45 minutes. A culture of the same type of cells which have not been transfected is incubated for the same time without the test compound to provide a negative control.

5

RNA is isolated from the two cultures as described in Chirgwin *et al.*, *Biochem. 18*, 5294-99, 1979). Northern blots are prepared using 20 to 30 µg total RNA and hybridized with a <sup>32</sup>P-labeled phospholipase A2-like enzyme-specific probe at 65°C in Express-hyb (CLONTECH). The probe comprises at least 11 contiguous nucleotides selected from the complement of SEQ ID NO:1, 3 or 8. A test compound which decreases the phospholipase A2-like enzyme-specific signal relative to the signal obtained in the absence of the test compound is identified as an inhibitor of phospholipase A2-like enzyme gene expression.

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#### EXAMPLE 5

*Identification of a test compound which decreases phospholipase A2-like enzyme activity*

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A test compound is administered to a culture of human cells transfected with a phospholipase A2-like enzyme expression construct and incubated at 37°C for 10 to 45 minutes. A culture of the same type of cells which have not been transfected is incubated for the same time without the test compound to provide a negative control.

25

A test compound which decreases the phospholipase A2 activity of the phospholipase A2-like enzyme relative to the phospholipase A2 activity in the absence of the test compound is identified as an inhibitor of phospholipase A2-like enzyme activity.



**EXAMPLE 6***Identification of molecules which interact with human phospholipase A2-like enzyme*

5 Human phospholipase A2-like enzyme or biologically active fragments thereof are labeled with  $^{125}\text{I}$  Bolton-Hunter reagent (Bolton *et al.*, *Biochem. J.* 133, 529, 1973). Candidate molecules previously arrayed in the wells of a multi-well plate are incubated with the labeled human phospholipase A2-like enzyme, washed, and any wells with labeled human phospholipase A2-like enzyme complex are assayed. Data  
10 obtained using different concentrations of human phospholipase A2-like enzyme are used to calculate values for the number, affinity, and association of human phospholipase A2-like enzyme with the candidate molecules.

**EXAMPLE 7**

15

*Tissue-specific expression of human phospholipase A2-like enzyme*

The qualitative expression pattern of human phospholipase A2-like enzyme in various tissues is determined by Reverse Transcription-Polymerase Chain Reaction  
20 (RT-PCR). To demonstrate that human phospholipase-like enzyme is involved in cancer, expression is determined in the following tissues: adrenal gland, bone marrow, brain, cerebellum, colon, fetal brain, fetal liver, heart, kidney, liver, lung, mammary gland, pancreas, placenta, prostate, salivary gland, skeletal muscle, small intestine, spinal cord, spleen, stomach, testis, thymus, thyroid, trachea, uterus, and  
25 peripheral blood lymphocytes. Expression in the following cancer cell lines also is determined: DU-145 (prostate), NCI-H125 (lung), HT-29 (colon), COLO-205 (colon), A-549 (lung), NCI-H460 (lung), HT-116 (colon), DLD-1 (colon), MDA-MD-231 (breast), LS174T (colon), ZF-75 (breast), MDA-MN-435 (breast), HT-1080, MCF-7 (breast), and U87. Matched pairs of malignant and normal tissue from the  
30 same patient also are tested.

To demonstrate that human phospholipase-like enzyme is involved in CNS disorders, the following tissues are screened: fetal and adult brain, muscle, heart, lung, kidney, liver, thymus, testis, colon, placenta, trachea, pancreas, kidney, gastric mucosa, colon, liver, cerebellum, skin, cortex (Alzheimer's and normal), hypothalamus, 5 cortex, amygdala, cerebellum, hippocampus, choroid, plexus, thalamus, and spinal cord.

To demonstrate that human phospholipase-like enzyme is involved in the disease process of COPD, the initial expression panel consists of RNA samples from 10 respiratory tissues and inflammatory cells relevant to COPD: lung (adult and fetal), trachea, freshly isolated alveolar type II cells, cultured human bronchial epithelial cells, cultured small airway epithelial cells, cultured bronchial smooth muscle cells, cultured H441 cells (Clara-like), freshly isolated neutrophils and monocytes, and cultured monocytes (macrophage-like). Body map profiling also is carried out, using 15 total RNA panels purchased from Clontech. The tissues are adrenal gland, bone marrow, brain, colon, heart, kidney, liver, lung, mammary gland, pancreas, prostate, salivary gland, skeletal muscle, small intestine, spleen, stomach, testis, thymus, trachea, thyroid, and uterus. As a final step, the expression of human phospholipase-like enzyme in cells derived from normal individuals with the expression of cells 20 derived from COPD-affected individuals is compared.

To demonstrate that human phospholipase-like enzyme is involved in the disease process of obesity, expression is determined in the following tissues: subcutaneous adipose tissue, mesenteric adipose tissue, adrenal gland, bone marrow, brain 25 (cerebellum, spinal cord, cerebral cortex, caudate, medulla, substantia nigra, and putamen), colon, fetal brain, heart, kidney, liver, lung, mammary gland, pancreas, placenta, prostate, salivary gland, skeletal muscle, small intestine, spleen, stomach, testes, thymus, thyroid, trachea, and uterus. Neuroblastoma cell lines SK-Nr-Be (2), Hr, Sk-N-As, HTB-10, IMR-32, SNSY-5Y, T3, SK-N-D2, D283, DAOY, CHP-2, 30 U87MG, BE(2)C, T986, KANTS, MO59K, CHP234, C6 (rat), SK-N-F1, SK-PU-DW, PFSK-1, BE(2)M17, and MCIXC also are tested for human phospholipase-like

enzyme expression. As a final step, the expression of human phospholipase-like enzyme in cells derived from normal individuals with the expression of cells derived from obese individuals is compared.

5 To demonstrate that human phospholipase A2-like enzyme is involved in the disease process of diabetes, the following whole body panel is screened to show predominant or relatively high expression: subcutaneous and mesenteric adipose tissue, adrenal gland, bone marrow, brain, colon, fetal brain, heart, hypothalamus, kidney, liver, lung, mammary gland, pancreas, placenta, prostate, salivary gland, skeletal muscle,  
10 small intestine, spleen, stomach, testis, thymus, thyroid, trachea, and uterus. Human islet cells and an islet cell library also are tested.

As a final step, the expression of human phospholipase A2-like enzyme in cells derived from normal individuals with the expression of cells derived from diabetic  
15 individuals is compared.

*Quantitative expression profiling.* Quantitative expression profiling is performed by the form of quantitative PCR analysis called "kinetic analysis" firstly described in Higuchi *et al.*, *BioTechnology* 10, 413-17, 1992, and Higuchi *et al.*, *BioTechnology*  
20 11, 1026-30, 1993. The principle is that at any given cycle within the exponential phase of PCR, the amount of product is proportional to the initial number of template copies.

If the amplification is performed in the presence of an internally quenched fluorescent oligonucleotide (TaqMan probe) complementary to the target sequence, the  
25 probe is cleaved by the 5'-3' endonuclease activity of Taq DNA polymerase and a fluorescent dye released in the medium (Holland *et al.*, *Proc. Natl. Acad. Sci. U.S.A.* 88, 7276-80, 1991). Because the fluorescence emission will increase in direct proportion to the amount of the specific amplified product, the exponential growth  
30 phase of PCR product can be detected and used to determine the initial template

concentration (Heid *et al.*, *Genome Res.* 6, 986-94, 1996, and Gibson *et al.*, *Genome Res.* 6, 995-1001, 1996).

5 The amplification of an endogenous control can be performed to standardize the amount of sample RNA added to a reaction. In this kind of experiment, the control of choice is the 18S ribosomal RNA. Because reporter dyes with differing emission spectra are available, the target and the endogenous control can be independently quantified in the same tube if probes labeled with different dyes are used.

10 All "real time PCR" measurements of fluorescence are made in the ABI Prism 7700.

*RNA extraction and cDNA preparation.* Total RNA from the tissues listed above are used for expression quantification. RNAs labeled "from autopsy" are extracted from autaptic tissues with the TRIzol reagent (Life Technologies, MD) according to the  
15 manufacturer's protocol.

Fifty µg of each RNA are treated with DNase I for 1 hour at 37 °C in the following reaction mix: 0.2 U/µl RNase-free DNase I (Roche Diagnostics, Germany); 0.4 U/µl RNase inhibitor (PE Applied Biosystems, CA); 10 mM Tris-HCl pH 7.9; 10 mM  
20 MgCl<sub>2</sub>; 50 mM NaCl; and 1 mM DTT.

After incubation, RNA is extracted once with 1 volume of phenol:chloroform:isoamyl alcohol (24:24:1) and once with chloroform, and precipitated with 1/10 volume of 3 M NaAcetate, pH5.2, and 2 volumes of ethanol.

25 Fifty µg of each RNA from the autaptic tissues are DNase treated with the DNA-free kit purchased from Ambion (Ambion, TX). After resuspension and spectrophotometric quantification, each sample is reverse transcribed with the TaqMan Reverse Transcription Reagents (PE Applied Biosystems, CA) according to the manufacturer's protocol. The final concentration of RNA in the reaction mix is  
30

200 ng/ $\mu$ L. Reverse transcription is carried out with 2.5 $\mu$ M of random hexamer primers.

*TaqMan quantitative analysis.* Specific primers and probe are designed according to the recommendations of PE Applied Biosystems, using the sequences disclosed herein. Probes can be labeled at the 5' end with FAM (6-carboxyfluorescein) and at the 3' end with TAMRA (6-carboxytetramethylrhodamine). Quantification experiments are performed on 10 ng of reverse transcribed RNA from each sample. Each determination is done in triplicate.

Total cDNA content is normalized with the simultaneous quantification (multiplex PCR) of the 18S ribosomal RNA using the Pre-Developed TaqMan Assay Reagents (PDAR) Control Kit (PE Applied Biosystems, CA).

The assay reaction mix is as follows: 1X final TaqMan Universal PCR Master Mix (from 2X stock) (PE Applied Biosystems, CA); 1X PDAR control - 18S RNA (from 20X stock); 300 nM forward primer; 900 nM reverse primer; 200 nM probe; 10 ng cDNA; and water to 25  $\mu$ L.

Each of the following steps are carried out once: pre PCR, 2 minutes at 50°C, and 10 minutes at 95°C. The following steps are carried out 40 times: denaturation, 15 seconds at 95°C, annealing/extension, 1 minute at 60°C.

The experiment is performed on an ABI Prism 7700 Sequence Detector (PE Applied Biosystems, CA). At the end of the run, fluorescence data acquired during PCR are processed as described in the ABI Prism 7700 user's manual in order to achieve better background subtraction as well as signal linearity with the starting target quantity.

**EXAMPLE 8***Quantitative Expression Profiling of the human phospholipase A2-like enzyme*

5 Expression profiling is based on a quantitative polymerase chain reaction (PCR) analysis, also called kinetic analysis, first described in Higuchi et al., 1992 and Higuchi et al., 1993. The principle is that at any given cycle within the exponential phase of PCR, the amount of product is proportional to the initial number of template copies. Using this technique, the expression levels of particular genes, which are  
10 transcribed from the chromosomes as messenger RNA (mRNA), are measured by first making a DNA copy (cDNA) of the mRNA, and then performing quantitative PCR on the cDNA, a method called quantitative reverse transcription-polymerase chain reaction (quantitative RT-PCR).

15 Quantitative RT-PCR analysis of RNA from different human tissues was performed to investigate the tissue distribution of LBRI target #364, Cytosolic phospholipase A2 beta homolog mRNA. 25 µg of total RNA from various tissues (Human Total RNA Panel I-V, Clontech Laboratories, Palo Alto, CA, USA) was used as a template to synthesize first-strand cDNA using the SUPERScript™ First-Strand Synthesis  
20 System for RT-PCR (Life Technologies, Rockville, MD, USA). First-strand cDNA synthesis was carried out according to the manufacturer's protocol using oligo (dT) to hybridize to the 3' poly A tails of mRNA and prime the synthesis reaction. 10 ng of the first-strand cDNA was then used as template in a polymerase chain reaction. The polymerase chain reaction was performed in a LightCycler (Roche Molecular  
25 Biochemicals, Indianapolis, IN, USA), in the presence of the DNA-binding fluorescent dye SYBR Green I which binds to the minor groove of the DNA double helix, produced only when double-stranded DNA is successfully synthesized in the reaction (Morrison et al., 1998). Upon binding to double-stranded DNA, SYBR Green I emits light that can be quantitatively measured by the LightCycler machine.  
30 The polymerase chain reaction was carried out using oligonucleotide primers LBRI\_364\_1plus2-L10 (SEQ ID NO:10) and LBRI\_364\_1plus2-R7 (SEQ ID

NO:11) and measurements of the intensity of emitted light were taken following each cycle of the reaction when the reaction had reached a temperature of 87 degrees C. Intensities of emitted light were converted into copy numbers of the gene transcript per nanogram of template cDNA by comparison with simultaneously reacted standards of known concentration.

To correct for differences in mRNA transcription levels per cell in the various tissue types, a normalization procedure was performed using similarly calculated expression levels in the various tissues of five different housekeeping genes: glyceraldehyde-3-phosphatase (G3PDH), hypoxanthine guanine phosphoribosyl transferase (HPRT), beta-actin, porphobilinogen deaminase (PBGD), and beta-2-microglobulin. The level of housekeeping gene expression is considered to be relatively constant for all tissues (Adams et al., 1993, Adams et al., 1995, Liew et al., 1994) and therefore can be used as a gauge to approximate relative numbers of cells per .mu.g of total RNA used in the cDNA synthesis step. Except for the use of a slightly different set of housekeeping genes and the use of the LightCycler system to measure expression levels, the normalization procedure was similar to that described in the RNA Master Blot User Manual, Appendix C (1997, Clontech Laboratories, Palo Alto, CA, USA). In brief, expression levels of the five housekeeping genes in all tissue samples were measured in three independent reactions per gene using the LightCycler and a constant amount (25 .mu.g) of starting RNA. The calculated copy numbers for each gene, derived from comparison with simultaneously reacted standards of known concentrations, were recorded and the mean number of copies of each gene in all tissue samples was determined. Then for each tissue sample, the expression of each housekeeping gene relative to the mean was calculated, and the average of these values over the five housekeeping genes was found. A normalization factor for each tissue was then calculated by dividing the final value for one of the tissues arbitrarily selected as a standard by the corresponding value for each of the tissues. To normalize an experimentally obtained value for the expression of a particular gene in a tissue sample, the obtained value was multiplied by the normalization factor for the tissue tested.

Results are shown in Fig. 17, showing the experimentally obtained copy numbers of mRNA per 10 ng of first-strand cDNA on the left and the normalized values on the right. RNAs used for the cDNA synthesis, along with their supplier and catalog numbers are shown in Table 1.

### References

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**Table 1** Whole-body-screen tissues

Tissue	Supplier	Panel name and catalog number
1. brain	Clontech	Human Total RNA Panel I, K4000-1
2. heart	Clontech	Human Total RNA Panel I, K4000-1
3. kidney	Clontech	Human Total RNA Panel I, K4000-1
4. liver	Clontech	Human Total RNA Panel I, K4000-1
5. lung	Clontech	Human Total RNA Panel I, K4000-1
6. trachea	Clontech	Human Total RNA Panel I, K4000-1
7. bone marrow	Clontech	Human Total RNA Panel II, K4001-1
8. colon	Clontech	Human Total RNA Panel II, K4001-1
9. small intestine	Clontech	Human Total RNA Panel II, K4001-1
10. spleen	Clontech	Human Total RNA Panel II, K4001-1
11. stomach	Clontech	Human Total RNA Panel II, K4001-1
12. thymus	Clontech	Human Total RNA Panel II, K4001-1
13. mammary gland	Clontech	Human Total RNA Panel III, K4002-1
14. skeletal muscle	Clontech	Human Total RNA Panel III, K4002-1
15. prostate	Clontech	Human Total RNA Panel III, K4002-1
16. testis	Clontech	Human Total RNA Panel III, K4002-1
17. uterus	Clontech	Human Total RNA Panel III, K4002-1
18. cerebellum	Clontech	Human Total RNA Panel IV, K4003-1
19. fetal brain	Clontech	Human Total RNA Panel IV, K4003-1
20. fetal liver	Clontech	Human Total RNA Panel IV, K4003-1
21. spinal cord	Clontech	Human Total RNA Panel IV, K4003-1
22. placenta	Clontech	Human Total RNA Panel IV, K4003-1
23. adrenal gland	Clontech	Human Total RNA Panel V, K4004-1
24. pancreas	Clontech	Human Total RNA Panel V, K4004-1
25. salivary gland	Clontech	Human Total RNA Panel V, K4004-1
26. thyroid	Clontech	Human Total RNA Panel V, K4004-1

**EXAMPLE 9***Diabetes: In vivo testing of compounds/target validation*

## 5      1.      Glucose Production

Over-production of glucose by the liver, due to an enhanced rate of gluconeogenesis, is the major cause of fasting hyperglycemia in diabetes. Overnight fasted normal rats or mice have elevated rates of gluconeogenesis as do streptozotocin-induced diabetic rats or mice fed ad libitum. Rats are made  
10      diabetic with a single intravenous injection of 40 mg/kg of streptozotocin while C57BL/KsJ mice are given 40-60 mg/kg i.p. for 5 consecutive days. Blood glucose is measured from tail-tip blood and then compounds are administered via different routes (p.o., i.p., i.v., s.c.). Blood is collected at  
15      various times thereafter and glucose measured. Alternatively, compounds are administered for several days, then the animals are fasted overnight, blood is collected and plasma glucose measured. Compounds that inhibit glucose production will decrease plasma glucose levels compared to the vehicle-treated control group.

20

## 2.      Insulin Sensitivity

Both ob/ob and db/db mice as well as diabetic Zucker rats are hyperglycemic, hyperinsulinemic and insulin resistant. The animals are pre-bled, their glucose  
25      levels measured, and then they are grouped so that the mean glucose level is the same for each group. Compounds are administered daily either q.d. or b.i.d. by different routes (p.o., i.p., s.c.) for 7-28 days. Blood is collected at various times and plasma glucose and insulin levels determined. Compounds that improve insulin sensitivity in these models will decrease both plasma  
30      glucose and insulin levels when compared to the vehicle-treated control group.

### 3. Insulin Secretion

5 Compounds that enhance insulin secretion from the pancreas will increase plasma insulin levels and improve the disappearance of plasma glucose following the administration of a glucose load. When measuring insulin levels, compounds are administered by different routes (p.o., i.p., s.c. or i.v.) to overnight fasted normal rats or mice. At the appropriate time an intravenous glucose load (0.4 g/kg) is given, blood is collected one minute later. Plasma insulin levels are determined. Compounds that enhance insulin secretion will increase plasma insulin levels compared to animals given only glucose. When measuring glucose disappearance, animals are bled at the appropriate time after compound administration, then given either an oral or intraperitoneal glucose load (1g/kg), bled again after 15, 30, 60 and 90 minutes and plasma glucose levels determined. Compounds that increase insulin levels will decrease glucose levels and the area-under-the glucose curve when compared to the vehicle-treated group given only glucose.

20 Compounds that enhance insulin secretion from the pancreas will increase plasma insulin levels and improve the disappearance of plasma glucose following the administration of a glucose load. When measuring insulin levels, test compounds which regulate pristanoyl-CoA oxidase-like enzyme are administered by different routes (p.o., i.p., s.c., or i.v.) to overnight fasted normal rats or mice. At the appropriate time an intravenous glucose load (0.4 g/kg) is given, blood is collected one minute later. Plasma insulin levels are determined. Test compounds that enhance insulin secretion will increase plasma insulin levels compared to animals given only glucose. When measuring glucose disappearance, animals are bled at the appropriate time after compound administration, then given either an oral or intraperitoneal glucose load (1g/kg), bled again after 15, 30, 60, and 90 minutes and plasma glucose levels determined. Test compounds that increase insulin levels will

decrease glucose levels and the area-under-the glucose curve when compared to the vehicle-treated group given only glucose.

#### 4. Glucose Production

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Over-production of glucose by the liver, due to an enhanced rate of gluconeogenesis, is the major cause of fasting hyperglycemia in diabetes. Overnight fasted normal rats or mice have elevated rates of gluconeogenesis as do streptozotocin-induced diabetic rats or mice fed ad libitum. Rats are made diabetic with a single intravenous injection of 40 mg/kg of streptozotocin while C57BL/KsJ mice are given 40-60 mg/kg i.p. for 5 consecutive days. Blood glucose is measured from tail-tip blood and then compounds are administered via different routes (p.o., i.p., i.v., s.c.). Blood is collected at various times thereafter and glucose measured. Alternatively, compounds are administered for several days, then the animals are fasted overnight, blood is collected and plasma glucose measured. Compounds that inhibit glucose production will decrease plasma glucose levels compared to the vehicle-treated control group.

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#### 5. Insulin Sensitivity

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Both ob/ob and db/db mice as well as diabetic Zucker rats are hyperglycemic, hyperinsulinemic and insulin resistant. The animals are pre-bled, their glucose levels measured, and then they are grouped so that the mean glucose level is the same for each group. Compounds are administered daily either q.d. or b.i.d. by different routes (p.o., i.p., s.c.) for 7-28 days. Blood is collected at various times and plasma glucose and insulin levels determined. Compounds that improve insulin sensitivity in these models will decrease both plasma glucose and insulin levels when compared to the vehicle-treated control group.

## 6. Insulin Secretion

Compounds that enhance insulin secretion from the pancreas will increase plasma insulin levels and improve the disappearance of plasma glucose following the administration of a glucose load. When measuring insulin levels, compounds are administered by different routes (p.o., i.p., s.c. or i.v.) to overnight fasted normal rats or mice. At the appropriate time an intravenous glucose load (0.4g/kg) is given, blood is collected one minute later. Plasma insulin levels are determined. Compounds that enhance insulin secretion will increase plasma insulin levels compared to animals given only glucose. When measuring glucose disappearance, animals are bled at the appropriate time after compound administration, then given either an oral or intraperitoneal glucose load (1g/kg), bled again after 15, 30, 60 and 90 minutes and plasma glucose levels determined. Compounds that increase insulin levels will decrease glucose levels and the area-under-the glucose curve when compared to the vehicle-treated group given only glucose.

### EXAMPLE 10

*Proliferation inhibition assay: Antisense oligonucleotides suppress the growth of cancer cell lines*

The cell line used for testing is the human colon cancer cell line HCT116. Cells are cultured in RPMI-1640 with 10-15% fetal calf serum at a concentration of 10,000 cells per milliliter in a volume of 0.5 ml and kept at 37°C in a 95% air/5%CO<sub>2</sub> atmosphere.

Phosphorothioate oligoribonucleotides are synthesized on an Applied Biosystems Model 380B DNA synthesizer using phosphoroamidite chemistry. A sequence of 24 bases complementary to the nucleotides at position 1 to 24 of SEQ ID NO:1 or 8 is used as the test oligonucleotide. As a control, another (random) sequence is used: 5'-

TCA ACT GAC TAG ATG TAC ATG GAC-3'. Following assembly and deprotection, oligonucleotides are ethanol-precipitated twice, dried, and suspended in phosphate buffered saline at the desired concentration. Purity of the oligonucleotides is tested by capillary gel electrophoresis and ion exchange HPLC. The purified oligonucleotides are added to the culture medium at a concentration of 10  $\mu$ M once per day for seven days.

The addition of the test oligonucleotide for seven days results in significantly reduced expression of human phospholipase A2-like enzyme as determined by Western blotting. This effect is not observed with the control oligonucleotide. After 3 to 7 days, the number of cells in the cultures is counted using an automatic cell counter. The number of cells in cultures treated with the test oligonucleotide (expressed as 100%) is compared with the number of cells in cultures treated with the control oligonucleotide. The number of cells in cultures treated with the test oligonucleotide is not more than 30% of control, indicating that the inhibition of human phospholipase A2-like enzyme has an anti-proliferative effect on cancer cells.

#### EXAMPLE 11

##### *In vivo testing of compounds/target validation*

#### 1. Acute Mechanistic Assays

##### *1.1. Reduction in Mitogenic Plasma Hormone Levels*

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This non-tumor assay measures the ability of a compound to reduce either the endogenous level of a circulating hormone or the level of hormone produced in response to a biologic stimulus. Rodents are administered test compound (p.o., i.p., i.v., i.m., or s.c.). At a pre-determined time after administration of test compound, blood plasma is collected. Plasma is assayed for levels of the hormone of interest.

5 If the normal circulating levels of the hormone are too low and/or variable to provide consistent results, the level of the hormone may be elevated by a pre-treatment with a biologic stimulus (i.e., LHRH may be injected i.m. into mice at a dosage of 30 ng/mouse to induce a burst of testosterone synthesis). The timing of plasma collection would be adjusted to coincide with the peak of the induced hormone response. Compound effects are compared to a vehicle-treated control group. An F-test is performed to determine if the variance is equal or unequal followed by a Student's t-test. Significance is p value  $\leq 0.05$  compared to the vehicle control group.

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### 1.2. *Hollow Fiber Mechanism of Action Assay*

15 Hollow fibers are prepared with desired cell line(s) and implanted intraperitoneally and/or subcutaneously in rodents. Compounds are administered p.o., i.p., i.v., i.m., or s.c. Fibers are harvested in accordance with specific readout assay protocol, these may include assays for gene expression (bDNA, PCR, or Taqman), or a specific biochemical activity (i.e., cAMP levels). Results are analyzed by Student's t-test or Rank Sum test after the variance between groups is compared by an F-test, with significance at  $p \leq 0.05$  as compared to the vehicle control group.

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## 2. *Subacute Functional In Vivo Assays*

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### 2.1. *Reduction in Mass of Hormone Dependent Tissues*

30 This is another non-tumor assay that measures the ability of a compound to reduce the mass of a hormone dependent tissue (i.e., seminal vesicles in males and uteri in females). Rodents are administered test compound (p.o., i.p., i.v., i.m., or s.c.) according to a

predetermined schedule and for a predetermined duration (i.e., 1 week). At termination of the study, animals are weighed, the target organ is excised, any fluid is expressed, and the weight of the organ is recorded. Blood plasma may also be collected. Plasma may be assayed for levels of a hormone of interest or for levels of test agent. Organ weights may be directly compared or they may be normalized for the body weight of the animal. Compound effects are compared to a vehicle-treated control group. An F-test is performed to determine if the variance is equal or unequal followed by a Student's t-test. Significance is  $p \text{ value} \leq 0.05$  compared to the vehicle control group.

## 2.2. *Hollow Fiber Proliferation Assay*

Hollow fibers are prepared with desired cell line(s) and implanted intraperitoneally and/or subcutaneously in rodents. Compounds are administered p.o., i.p., i.v., i.m., or s.c. Fibers are harvested in accordance with specific readout assay protocol. Cell proliferation is determined by measuring a marker of cell number (i.e., MTT or LDH). The cell number and change in cell number from the starting inoculum are analyzed by Student's t-test or Rank Sum test after the variance between groups is compared by an F-test, with significance at  $p \leq 0.05$  as compared to the vehicle control group.

## 2.3. *Anti-angiogenesis Models*

### 2.3.1. *Corneal Angiogenesis*

Hydron pellets with or without growth factors or cells are implanted into a micropocket surgically created in the rodent cornea. Compound administration may be systemic or local (compound mixed with growth factors in the hydron pellet).



5 Corneas are harvested at 7 days post implantation immediately following intracardiac infusion of colloidal carbon and are fixed in 10% formalin. Readout is qualitative scoring and/or image analysis. Qualitative scores are compared by Rank Sum test. Image analysis data is evaluated by measuring the area of neovascularization (in pixels) and group averages are compared by Student's t-test (2 tail). Significance is  $p \leq 0.05$  as compared to the growth factor or cells only group.

#### 10 2.3.2. *Matrigel Angiogenesis*

15 Matrigel, containing cells or growth factors, is injected subcutaneously. Compounds are administered p.o., i.p., i.v., i.m., or s.c. Matrigel plugs are harvested at predetermined time point(s) and prepared for readout. Readout is an ELISA-based assay for hemoglobin concentration and/or histological examination (i.e. vessel count, special staining for endothelial surface markers: CD31, factor-8). Readouts are analyzed by Student's t-test, after the variance between groups is compared by an F-test, with significance determined at  $p \leq 0.05$  as compared to the vehicle control group.

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### 3. Primary Antitumor Efficacy

#### 25 3.1. *Early Therapy Models*

##### 3.1.1. *Subcutaneous Tumor*

30 Tumor cells or fragments are implanted subcutaneously on Day 0. Vehicle and/or compounds are administered p.o., i.p., i.v., i.m., or s.c. according to a predetermined schedule starting

at a time, usually on Day 1, prior to the ability to measure the tumor burden. Body weights and tumor measurements are recorded 2-3 times weekly. Mean net body and tumor weights are calculated for each data collection day. Anti-tumor efficacy may be initially determined by comparing the size of treated (T) and control (C) tumors on a given day by a Student's t-test, after the variance between groups is compared by an F-test, with significance determined at  $p \leq 0.05$ . The experiment may also be continued past the end of dosing in which case tumor measurements would continue to be recorded to monitor tumor growth delay. Tumor growth delays are expressed as the difference in the median time for the treated and control groups to attain a predetermined size divided by the median time for the control group to attain that size. Growth delays are compared by generating Kaplan-Meier curves from the times for individual tumors to attain the evaluation size. Significance is  $p \leq 0.05$ .

### 3.1.2. Intraperitoneal/Intracranial Tumor Models

Tumor cells are injected intraperitoneally or intracranially on Day 0. Compounds are administered p.o., i.p., i.v., i.m., or s.c. according to a predetermined schedule starting on Day 1. Observations of morbidity and/or mortality are recorded twice daily. Body weights are measured and recorded twice weekly. Morbidity/mortality data is expressed in terms of the median time of survival and the number of long-term survivors is indicated separately. Survival times are used to generate Kaplan-Meier curves. Significance is  $p \leq 0.05$  by a log-rank test compared to the control group in the experiment.

### 3.2. *Established Disease Model*

Tumor cells or fragments are implanted subcutaneously and grown to the desired size for treatment to begin. Once at the predetermined size range, mice are randomized into treatment groups. Compounds are administered p.o., i.p., i.v., i.m., or s.c. according to a predetermined schedule. Tumor and body weights are measured and recorded 2-3 times weekly. Mean tumor weights of all groups over days post inoculation are graphed for comparison. An F-test is preformed to determine if the variance is equal or unequal followed by a Student's t-test to compare tumor sizes in the treated and control groups at the end of treatment. Significance is  $p \leq 0.05$  as compared to the control group. Tumor measurements may be recorded after dosing has stopped to monitor tumor growth delay. Tumor growth delays are expressed as the difference in the median time for the treated and control groups to attain a predetermined size divided by the median time for the control group to attain that size. Growth delays are compared by generating Kaplan-Meier curves from the times for individual tumors to attain the evaluation size. Significance is  $p \text{ value} \leq 0.05$  compared to the vehicle control group.

### 3.3. *Orthotopic Disease Models*

#### 3.3.1. *Mammary Fat Pad Assay*

Tumor cells or fragments, of mammary adenocarcinoma origin, are implanted directly into a surgically exposed and reflected mammary fat pad in rodents. The fat pad is placed back in its original position and the surgical site is closed. Hormones may also be administered to the rodents to support the growth of the tumors. Compounds are administered p.o.,

i.p., i.v., i.m., or s.c. according to a predetermined schedule. Tumor and body weights are measured and recorded 2-3 times weekly. Mean tumor weights of all groups over days post inoculation are graphed for comparison. An F-test is preformed to determine if the variance is equal or unequal followed by a Student's t-test to compare tumor sizes in the treated and control groups at the end of treatment. Significance is  $p \leq 0.05$  as compared to the control group.

Tumor measurements may be recorded after dosing has stopped to monitor tumor growth delay. Tumor growth delays are expressed as the difference in the median time for the treated and control groups to attain a predetermined size divided by the median time for the control group to attain that size. Growth delays are compared by generating Kaplan-Meier curves from the times for individual tumors to attain the evaluation size. Significance is  $p \text{ value} \leq 0.05$  compared to the vehicle control group. In addition, this model provides an opportunity to increase the rate of spontaneous metastasis of this type of tumor. Metastasis can be assessed at termination of the study by counting the number of visible foci per target organ, or measuring the target organ weight. The means of these endpoints are compared by Student's t-test after conducting an F-test, with significance determined at  $p \leq 0.05$  compared to the control group in the experiment.

### 3.3.2. *Intraprostatic Assay*

Tumor cells or fragments, of prostatic adenocarcinoma origin, are implanted directly into a surgically exposed dorsal lobe of the prostate in rodents. The prostate is externalized through an

5 abdominal incision so that the tumor can be implanted specifically in the dorsal lobe while verifying that the implant does not enter the seminal vesicles. The successfully inoculated prostate is replaced in the abdomen and the incisions through the abdomen and skin are closed. Hormones may also be administered to the rodents to support the growth of the tumors. Compounds are administered p.o., i.p., i.v., i.m., or s.c. according to a predetermined schedule. Body weights are measured and recorded 2-3 times weekly. At a pre-determined time, the experiment is terminated and the animal is dissected. The size of the primary tumor is measured in 10 three dimensions using either a caliper or an ocular micrometer attached to a dissecting scope. An F-test is performed to determine if the variance is equal or unequal followed by a Student's t-test to compare tumor sizes in the treated and 15 control groups at the end of treatment. Significance is  $p \leq 0.05$  as compared to the control group. This model provides an opportunity to increase the rate of spontaneous metastasis of this type of tumor. Metastasis can be assessed at termination of the study by counting the number of visible foci per target 20 organ (i.e., the lungs), or measuring the target organ weight (i.e., the regional lymph nodes). The means of these endpoints are compared by Student's t-test after conducting an F-test, with significance determined at  $p \leq 0.05$  compared to the 25 control group in the experiment.

### 3.3.3. Intrabronchial Assay

30 Tumor cells of pulmonary origin may be implanted intrabronchially by making an incision through the skin and exposing the trachea. The trachea is pierced with the beveled

- 97 -

5 end of a 25 gauge needle and the tumor cells are inoculated into the main bronchus using a flat-ended 27 gauge needle with a 90° bend. Compounds are administered p.o., i.p., i.v., i.m., or s.c. according to a predetermined schedule. Body weights are measured and recorded 2-3 times weekly. At a predetermined time, the experiment is terminated and the animal is dissected. The size of the primary tumor is measured in three dimensions using either a caliper or an ocular micrometer attached to a dissecting scope. An F-test is performed to determine if the variance is equal or unequal followed by a Student's t-test to compare tumor sizes in the treated and control groups at the end of treatment. Significance is  $p \leq 0.05$  as compared to the control group. This model provides an opportunity to increase the rate of spontaneous metastasis of this type of tumor. Metastasis can be assessed at termination of the study by counting the number of visible foci per target organ (i.e., the contralateral lung), or measuring the target organ weight. The means of these endpoints are compared by Student's t-test after conducting an F-test, with significance determined at  $p \leq 0.05$  compared to the control group in the experiment.

#### 3.3.4. Intracecal Assay

25 Tumor cells of gastrointestinal origin may be implanted intracecally by making an abdominal incision through the skin and externalizing the intestine. Tumor cells are inoculated into the cecal wall without penetrating the lumen of the intestine using a 27 or 30 gauge needle. Compounds are administered p.o., i.p., i.v., i.m., or s.c. according to a predetermined schedule. Body weights are measured and recorded 2-3 times weekly. At a predetermined time, the experiment is terminated and the

5 animal is dissected. The size of the primary tumor is measured  
in three dimensions using either a caliper or an ocular  
micrometer attached to a dissecting scope. An F-test is  
performed to determine if the variance is equal or unequal  
10 followed by a Student's t-test to compare tumor sizes in the  
treated and control groups at the end of treatment. Significance  
is  $p \leq 0.05$  as compared to the control group. This model  
provides an opportunity to increase the rate of spontaneous  
metastasis of this type of tumor. Metastasis can be assessed at  
15 termination of the study by counting the number of visible foci  
per target organ (i.e., the liver), or measuring the target organ  
weight. The means of these endpoints are compared by  
Student's t-test after conducting an F-test, with significance  
determined at  $p \leq 0.05$  compared to the control group in the  
experiment.

#### 4. Secondary (Metastatic) Antitumor Efficacy

##### 4.1. Spontaneous Metastasis

20 Tumor cells are inoculated s.c. and the tumors allowed to grow to a  
predetermined range for spontaneous metastasis studies to the lung or  
liver. These primary tumors are then excised. Compounds are  
administered p.o., i.p., i.v., i.m., or s.c. according to a predetermined  
25 schedule which may include the period leading up to the excision of  
the primary tumor to evaluate therapies directed at inhibiting the early  
stages of tumor metastasis. Observations of morbidity and/or  
mortality are recorded daily. Body weights are measured and recorded  
twice weekly. Potential endpoints include survival time, numbers of  
30 visible foci per target organ, or target organ weight. When survival  
time is used as the endpoint the other values are not determined.

Survival data is used to generate Kaplan-Meier curves. Significance is  $p \leq 0.05$  by a log-rank test compared to the control group in the experiment. The mean number of visible tumor foci, as determined under a dissecting microscope, and the mean target organ weights are compared by Student's t-test after conducting an F-test, with significance determined at  $p \leq 0.05$  compared to the control group in the experiment for both of these endpoints.

#### 4.2. *Forced Metastasis*

Tumor cells are injected into the tail vein, portal vein, or the left ventricle of the heart in experimental (forced) lung, liver, and bone metastasis studies, respectively. Compounds are administered p.o., i.p., i.v., i.m., or s.c. according to a predetermined schedule. Observations of morbidity and/or mortality are recorded daily. Body weights are measured and recorded twice weekly. Potential endpoints include survival time, numbers of visible foci per target organ, or target organ weight. When survival time is used as the endpoint the other values are not determined. Survival data is used to generate Kaplan-Meier curves. Significance is  $p \leq 0.05$  by a log-rank test compared to the control group in the experiment. The mean number of visible tumor foci, as determined under a dissecting microscope, and the mean target organ weights are compared by Student's t-test after conducting an F-test, with significance at  $p \leq 0.05$  compared to the vehicle control group in the experiment for both endpoints.



**EXAMPLE 12*****In vivo testing of compounds/target validation***5      1.      **Pain*****Acute Pain***

10      Acute pain is measured on a hot plate mainly in rats. Two variants of hot plate testing are used: In the classical variant animals are put on a hot surface (52 to 56°C) and the latency time is measured until the animals show nocifensive behavior, such as stepping or foot licking. The other variant is an increasing temperature hot plate where the experimental animals are put on a surface of neutral temperature. Subsequently this surface is slowly but constantly heated  
15      until the animals begin to lick a hind paw. The temperature which is reached when hind paw licking begins is a measure for pain threshold.

20      Compounds are tested against a vehicle treated control group. Substance application is performed at different time points via different application routes (i.v., i.p., p.o., i.t., i.c.v., s.c., intradermal, transdermal) prior to pain testing.

***Persistent Pain***

25      Persistent pain is measured with the formalin or capsaicin test, mainly in rats. A solution of 1 to 5% formalin or 10 to 100 µg capsaicin is injected into one hind paw of the experimental animal. After formalin or capsaicin application the animals show nocifensive reactions like flinching, licking and biting of the affected paw. The number of nocifensive reactions within a time frame of  
30      up to 90 minutes is a measure for intensity of pain.

Compounds are tested against a vehicle treated control group. Substance application is performed at different time points via different application routes (i.v., i.p., p.o., i.t., i.c.v., s.c., intradermal, transdermal) prior to formalin or capsaicin administration.

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### *Neuropathic Pain*

Neuropathic pain is induced by different variants of unilateral sciatic nerve injury mainly in rats. The operation is performed under anesthesia. The first variant of sciatic nerve injury is produced by placing loosely constrictive ligatures around the common sciatic nerve. The second variant is the tight ligation of about the half of the diameter of the common sciatic nerve. In the next variant, a group of models is used in which tight ligations or transections are made of either the L5 and L6 spinal nerves, or the L<sub>6</sub> spinal nerve only. The fourth variant involves an axotomy of two of the three terminal branches of the sciatic nerve (tibial and common peroneal nerves) leaving the remaining sural nerve intact whereas the last variant comprises the axotomy of only the tibial branch leaving the sural and common nerves uninjured. Control animals are treated with a sham operation.

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Postoperatively, the nerve injured animals develop a chronic mechanical allodynia, cold allodynia, as well as a thermal hyperalgesia. Mechanical allodynia is measured by means of a pressure transducer (electronic von Frey Anesthesiometer, IITC Inc.-Life Science Instruments, Woodland Hills, SA, USA; Electronic von Frey System, Somedic Sales AB, Hörby, Sweden). Thermal hyperalgesia is measured by means of a radiant heat source (Plantar Test, Ugo Basile, Comerio, Italy), or by means of a cold plate of 5 to 10 °C where the nocifensive reactions of the affected hind paw are counted as a measure of pain intensity. A further test for cold induced pain is the counting of nocifensive reactions, or duration of nocifensive responses after plantar administration of acetone to the affected hind limb. Chronic pain in general is

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assessed by registering the circadian rhythms in activity (Surjo and Arndt, Universität zu Köln, Cologne, Germany), and by scoring differences in gait (foot print patterns; FOOTPRINTS program, Klapdor et al., 1997. A low cost method to analyze footprint patterns. J. Neurosci. Methods 75, 49-54).

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Compounds are tested against sham operated and vehicle treated control groups. Substance application is performed at different time points via different application routes (i.v., i.p., p.o., i.t., i.c.v., s.c., intradermal, transdermal) prior to pain testing.

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### *Inflammatory Pain*

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Inflammatory pain is induced mainly in rats by injection of 0.75 mg carrageenan or complete Freund's adjuvant into one hind paw. The animals develop an edema with mechanical allodynia as well as thermal hyperalgesia. Mechanical allodynia is measured by means of a pressure transducer (electronic von Frey Anesthesiometer, IITC Inc.-Life Science Instruments, Woodland Hills, SA, USA). Thermal hyperalgesia is measured by means of a radiant heat source (Plantar Test, Ugo Basile, Comerio, Italy, Paw thermal stimulator, G. Ozaki, University of California, USA). For edema measurement two methods are being used. In the first method, the animals are sacrificed and the affected hindpaws sectioned and weighed. The second method comprises differences in paw volume by measuring water displacement in a plethysmometer (Ugo Basile, Comerio, Italy).

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Compounds are tested against uninflamed as well as vehicle treated control groups. Substance application is performed at different time points via different application routes (i.v., i.p., p.o., i.t., i.c.v., s.c., intradermal, transdermal) prior to pain testing.

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### *Diabetic Neuropathic Pain*

5 Rats treated with a single intraperitoneal injection of 50 to 80 mg/kg streptozotocin develop a profound hyperglycemia and mechanical allodynia within 1 to 3 weeks. Mechanical allodynia is measured by means of a pressure transducer (electronic von Frey Anesthesiometer, IITC Inc.-Life Science Instruments, Woodland Hills, SA, USA).

10 Compounds are tested against diabetic and non-diabetic vehicle treated control groups. Substance application is performed at different time points via different application routes (i.v., i.p., p.o., i.t., i.c.v., s.c., intradermal, transdermal) prior to pain testing.

## 2. Parkinson's disease

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### *6-Hydroxydopamine (6-OH-DA) Lesion*

20 Degeneration of the dopaminergic nigrostriatal and striatopallidal pathways is the central pathological event in Parkinson's disease. This disorder has been mimicked experimentally in rats using single/sequential unilateral stereotaxic injections of 6-OH-DA into the medium forebrain bundle (MFB).

25 Male Wistar rats (Harlan Winkelmann, Germany), weighing 200±250 g at the beginning of the experiment, are used. The rats are maintained in a temperature- and humidity-controlled environment under a 12 h light/dark cycle with free access to food and water when not in experimental sessions. The following in vivo protocols are approved by the governmental authorities. All efforts are made to minimize animal suffering, to reduce the number of animals used, and to utilize alternatives to in vivo techniques.

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Animals are administered pargyline on the day of surgery (Sigma, St. Louis, MO, USA; 50 mg/kg i.p.) in order to inhibit metabolism of 6-OHDA by monoamine oxidase and desmethylinipramine HCl (Sigma; 25 mg/kg i.p.) in order to prevent uptake of 6-OHDA by noradrenergic terminals. Thirty minutes later the rats are anesthetized with sodium pentobarbital (50 mg/kg) and placed in a stereotaxic frame. In order to lesion the DA nigrostriatal pathway 4 µl of 0.01% ascorbic acid-saline containing 8 µg of 6-OHDA HBr (Sigma) are injected into the left medial fore-brain bundle at a rate of 1 µl/min (2.4 mm anterior, 1.49 mm lateral, -2.7 mm ventral to Bregma and the skull surface). The needle is left in place an additional 5 min to allow diffusion to occur.

#### Stepping Test

Forelimb akinesia is assessed three weeks following lesion placement using a modified stepping test protocol. In brief, the animals are held by the experimenter with one hand fixing the hindlimbs and slightly raising the hind part above the surface. One paw is touching the table, and is then moved slowly sideways (5 s for 1 m), first in the forehand and then in the backhand direction. The number of adjusting steps is counted for both paws in the backhand and forehand direction of movement. The sequence of testing is right paw forehand and backhand adjusting stepping, followed by left paw forehand and backhand directions. The test is repeated three times on three consecutive days, after an initial training period of three days prior to the first testing. Forehand adjusted stepping reveals no consistent differences between lesioned and healthy control animals. Analysis is therefore restricted to backhand adjusted stepping.

### Balance Test

Balance adjustments following postural challenge are also measured during the stepping test sessions. The rats are held in the same position as described in the stepping test and, instead of being moved sideways, tilted by the experimenter towards the side of the paw touching the table. This maneuver results in loss of balance and the ability of the rats to regain balance by forelimb movements is scored on a scale ranging from 0 to 3. Score 0 is given for a normal forelimb placement. When the forelimb movement is delayed but recovery of postural balance detected, score 1 is given. Score 2 represents a clear, yet insufficient, forelimb reaction, as evidenced by muscle contraction, but lack of success in recovering balance, and score 3 is given for no reaction of movement. The test is repeated three times a day on each side for three consecutive days after an initial training period of three days prior to the first testing.

### Staircase Test (Paw Reaching)

A modified version of the staircase test is used for evaluation of paw reaching behavior three weeks following primary and secondary lesion placement. Plexiglass test boxes with a central platform and a removable staircase on each side are used. The apparatus is designed such that only the paw on the same side at each staircase can be used, thus providing a measure of independent forelimb use. For each test the animals are left in the test boxes for 15 min. The double staircase is filled with 7 x 3 chow pellets (Precision food pellets, formula: P, purified rodent diet, size 45 mg; Sandown Scientific) on each side. After each test the number of pellets eaten (successfully retrieved pellets) and the number of pellets taken (touched but dropped) for each paw and the success rate (pellets eaten/pellets taken) are counted separately. After three days of food deprivation (12 g per animal per day) the

animals are tested for 11 days. Full analysis is conducted only for the last five days.

#### *MPTP treatment*

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The neurotoxin 1-methyl-4-phenyl-1,2,3,6-tetrahydro-pyridine (MPTP) causes degeneration of mesencephalic dopaminergic (DAergic) neurons in rodents, non-human primates, and humans and, in so doing, reproduces many of the symptoms of Parkinson's disease. MPTP leads to a marked decrease in the levels of dopamine and its metabolites, and in the number of dopaminergic terminals in the striatum as well as severe loss of the tyrosine hydroxylase (TH)-immunoreactive cell bodies in the substantia nigra, pars compacta.

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In order to obtain severe and long-lasting lesions, and to reduce mortality, animals receive single injections of MPTP, and are then tested for severity of lesion 7-10 days later. Successive MPTP injections are administered on days 1, 2 and 3. Animals receive application of 4 mg/kg MPTP hydrochloride (Sigma) in saline once daily. All injections are intraperitoneal (i.p.) and the MPTP stock solution is frozen between injections. Animals are decapitated on day 11.

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#### Immunohistology

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At the completion of behavioral experiments, all animals are anaesthetized with 3 ml thiopental (1 g/40 ml i.p., Tyrol Pharma). The mice are perfused transcardially with 0.01 M PBS (pH 7.4) for 2 min, followed by 4% paraformaldehyde (Merck) in PBS for 15 min. The brains are removed and placed in 4% paraformaldehyde for 24 h at 4°C. For dehydration they are then transferred to a 20% sucrose (Merck) solution in 0.1 M PBS at 4°C until they sink. The brains are frozen in methylbutan at -20°C for 2 min and stored at

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-70°C. Using a sledge microtome (mod. 3800-Frigocut, Leica), 25 µm sections are taken from the genu of the corpus callosum (AP 1.7 mm) to the hippocampus (AP 21.8 mm) and from AP 24.16 to AP 26.72. Forty-six sections are cut and stored in assorters in 0.25 M Tris buffer (pH 7.4) for immunohistochemistry.

A series of sections is processed for free-floating tyrosine hydroxylase (TH) immunohistochemistry. Following three rinses in 0.1 M PBS, endogenous peroxidase activity is quenched for 10 min in 0.3% H<sub>2</sub>O<sub>2</sub> ± PBS. After rinsing in PBS, sections are preincubated in 10% normal bovine serum (Sigma) for 5 min as blocking agent and transferred to either primary anti-rat TH rabbit antiserum (dilution 1:2000).

Following overnight incubation at room temperature, sections for TH immunoreactivity are rinsed in PBS (2 x 10 min) and incubated in biotinylated anti-rabbit immunoglobulin G raised in goat (dilution 1:200) (Vector) for 90 min, rinsed repeatedly and transferred to Vectastain ABC (Vector) solution for 1 h. 3,3' -Diaminobenzidine tetrahydrochloride (DAB; Sigma) in 0.1 M PBS, supplemented with 0.005% H<sub>2</sub>O<sub>2</sub>, serves as chromogen in the subsequent visualization reaction. Sections are mounted on to gelatin-coated slides, left to dry overnight, counter-stained with hematoxylin dehydrated in ascending alcohol concentrations and cleared in butylacetate. Coverslips are mounted on entellan.

#### Rotarod Test

We use a modification of the procedure described by Rozas and Labandeira-Garcia (1997), with a CR-1 Rotamex system (Columbus Instruments, Columbus, OH) comprising an IBM-compatible personal computer, a CIO-24 data acquisition card, a control unit, and a four-lane rotarod unit. The rotarod unit consists of a rotating spindle (diameter 7.3 cm)



and individual compartments for each mouse. The system software allows preprogramming of session protocols with varying rotational speeds (0-80 rpm). Infrared beams are used to detect when a mouse has fallen onto the base grid beneath the rotarod. The system logs the fall as the end of the experiment for that mouse, and the total time on the rotarod, as well as the time of the fall and all the set-up parameters, are recorded. The system also allows a weak current to be passed through the base grid, to aid training.

### 3. Dementia

#### The object recognition task

The object recognition task has been designed to assess the effects of experimental manipulations on the cognitive performance of rodents. A rat is placed in an open field, in which two identical objects are present. The rats inspects both objects during the first trial of the object recognition task. In a second trial, after a retention interval of for example 24 hours, one of the two objects used in the first trial, the 'familiar' object, and a novel object are placed in the open field. The inspection time at each of the objects is registered. The basic measures in the OR task is the time spent by a rat exploring the two object the second trial. Good retention is reflected by higher exploration times towards the novel than the 'familiar' object.

Administration of the putative cognition enhancer prior to the first trial predominantly allows assessment of the effects on acquisition, and eventually on consolidation processes. Administration of the testing compound after the first trial allows to assess the effects on consolidation processes, whereas administration before the second trial allows to measure effects on retrieval processes.

*The passive avoidance task*

5 The passive avoidance task assesses memory performance in rats and mice. The inhibitory avoidance apparatus consists of a two-compartment box with a light compartment and a dark compartment. The two compartments are separated by a guillotine door that can be operated by the experimenter. A threshold of 2 cm separates the two compartments when the guillotine door is raised. When the door is open, the illumination in the dark compartment is about 2 lux. The light intensity is about 500 lux at the center of the floor of the light compartment.

10 Two habituation sessions, one shock session, and a retention session are given, separated by inter-session intervals of 24 hours. In the habituation sessions and the retention session the rat is allowed to explore the apparatus for 300 sec. The rat is placed in the light compartment, facing the wall opposite to the guillotine door. After an accommodation period of 15 sec. the guillotine door is opened so that all parts of the apparatus can be visited freely. Rats normally avoid brightly lit areas and will enter the dark compartment within a few seconds.

20 In the shock session the guillotine door between the compartments is lowered as soon as the rat has entered the dark compartment with its four paws, and a scrambled 1 mA footshock is administered for 2 sec. The rat is removed from the apparatus and put back into its home cage. The procedure during the retention session is identical to that of the habituation sessions.

25 The step-through latency, that is the first latency of entering the dark compartment (in sec.) during the retention session is an index of the memory performance of the animal; the longer the latency to enter the dark compartment, the better the retention is. A testing compound is given half an hour before the shock session, together with 1 mg\*kg<sup>-1</sup> scopolamine.

Scopolamine impairs the memory performance during the retention session 24 hours later. If the test compound increases the enter latency compared with the scopolamine-treated controls, is likely to possess cognition enhancing potential.

5

### *The Morris water escape task*

The Morris water escape task measures spatial orientation learning in rodents. It is a test system that has extensively been used to investigate the effects of putative therapeutic on the cognitive functions of rats and mice. The performance of an animal is assessed in a circular water tank with an escape platform that is submerged about 1 cm below the surface of the water. The escape platform is not visible for an animal swimming in the water tank. Abundant extra-maze cues are provided by the furniture in the room, including desks, computer equipment, a second water tank, the presence of the experimenter, and by a radio on a shelf that is playing softly.

The animals receive four trials during five daily acquisition sessions. A trial is started by placing an animal into the pool, facing the wall of the tank. Each of four starting positions in the quadrants north, east, south, and west is used once in a series of four trials; their order is randomized. The escape platform is always in the same position. A trial is terminated as soon as the animal had climbs onto the escape platform or when 90 seconds have elapsed, whichever event occurs first. The animal is allowed to stay on the platform for 30 seconds. Then it is taken from the platform and the next trial is started. If an animal did not find the platform within 90 seconds it is put on the platform by the experimenter and is allowed to stay there for 30 seconds. After the fourth trial of the fifth daily session, an additional trial is given as a probe trial: the platform is removed, and the time the animal spends in the four quadrants is measured for 30 or 60 seconds. In the probe trial, all animals start from the

same start position, opposite to the quadrant where the escape platform had been positioned during acquisition.

5 Four different measures are taken to evaluate the performance of an animal during acquisition training: escape latency, traveled distance, distance to platform, and swimming speed. The following measures are evaluated for the probe trial: time (s) in quadrants and traveled distance (cm) in the four quadrants. The probe trial provides additional information about how well an animal learned the position of the escape platform. If an animal spends more  
10 time and swims a longer distance in the quadrant where the platform had been positioned during the acquisition sessions than in any other quadrant, one concludes that the platform position has been learned well.

15 In order to assess the effects of putative cognition enhancing compounds, rats or mice with specific brain lesions which impair cognitive functions, or animals treated with compounds such as scopolamine or MK-801, which interfere with normal learning, or aged animals which suffer from cognitive deficits, are used.

#### 20 *The T-maze spontaneous alternation task*

The T-maze spontaneous alternation task (TeMCAT) assesses the spatial memory performance in mice. The start arm and the two goal arms of the T-maze are provided with guillotine doors which can be operated manually by  
25 the experimenter. A mouse is put into the start arm at the beginning of training. The guillotine door is closed. In the first trial, the 'forced trial', either the left or right goal arm is blocked by lowering the guillotine door. After the mouse has been released from the start arm, it will negotiate the maze, eventually enter the open goal arm, and return to the start position,  
30 where it will be confined for 5 seconds, by lowering the guillotine door. Then, the animal can choose freely between the left and right goal arm (all

guillotine-doors opened) during 14 'free choice' trials. As soon as the mouse has entered one goal arm, the other one is closed. The mouse eventually returns to the start arm and is free to visit whichever goal arm it wants after having been confined to the start arm for 5 seconds. After completion of 14 free choice trials in one session, the animal is removed from the maze. During training, the animal is never handled.

The percent alternations out of 14 trials is calculated. This percentage and the total time needed to complete the first forced trial and the subsequent 14 free choice trials (in s) is analyzed. Cognitive deficits are usually induced by an injection of scopolamine, 30 min before the start of the training session. Scopolamine reduced the per-cent alternations to chance level, or below. A cognition enhancer, which is always administered before the training session, will at least partially, antagonize the scopolamine-induced reduction in the spontaneous alternation rate.

### EXAMPLE 13

*Treatment of asthma with a reagent that specifically binds to a sphingosine kinase-like protein gene product*

Synthesis of antisense sphingosine kinase-like protein oligonucleotides comprising at least 11 contiguous nucleotides selected from the complement of SEQ ID NOS:1 and 9 is performed on a Pharmacia Gene Assembler series synthesizer using the phosphoramidite procedure (Uhlmann *et al.*, *Chem. Rev.* 90, 534-83, 1990). Following assembly and deprotection, oligonucleotides are ethanol-precipitated twice, dried, and suspended in phosphate-buffered saline (PBS) at the desired concentration. Purity of these oligonucleotides is tested by capillary gel electrophoreses and ion exchange HPLC. Endotoxin levels in the oligonucleotide preparation are determined using the *Limulus* Amebocyte Assay (Bang, *Biol. Bull. (Woods Hole, Mass.)* 105, 361-362, 1953).

An aqueous composition containing the antisense oligonucleotides is administered to the patient by inhalation.

- 5      Severity of asthma is monitored over a period of days or weeks by noting changes in patients' asthmatic symptoms, measuring lung function, or measuring changes in markers of lung inflammation such as numbers of inflammatory cells or concentrations of inflammatory mediators in fluid sampled from patients' lungs by bronchoalveolar lavage. Asthma severity is reduced due to decreased sphingosine  
10      kinase-like protein activity.

#### EXAMPLE 14

##### *In vivo validation of novel compounds*

15

1.      Tests for activity of T cells are used to evaluate agents that modulate the expression or activity of costimulatory molecules-cytokines, cytokine receptors, signalling molecules, or other molecules involved in T cell activation

20

##### *Mouse anti-CD3-induced cytokine production model:*

25

BALB/c mice are injected with a single intravenous injection of 10 µg of 145-2C11 (purified hamster anti-mouse CD3 monoclonal antibodies, PHARMINGEN). Compound is administered intraperitoneally 60 min prior to the anti-CD3 mAb injection. Blood is collected 90 min after the antibody injection. Serum is obtained by centrifugation at 3000 r.p.m. for 10 min. Serum levels of cytokines, such as IL-2 and IL-4, or other secreted molecules are determined by an ELISA. Proteins which regulate the CD3 downstream  
30      signaling can be evaluated in this model.

2. Tests for activity of B cells are used to evaluate agents that modulate the expression or activity of the B cell receptor, signaling molecules, or other molecules involved in B cell activation/immunoglobulin class switching

5 *Mouse anti-IgD induced IgE production model:*

BALB/c mice are injected intravenously with 0.8 mg of purified goat anti-mouse IgD antibody or PBS (defined as day 0). Compound is administered intraperitoneally from day 0 to day 6. On day 7 blood is collected and serum is obtained by centrifugation at 3000 r.p.m. for 10 min. Serum levels of total IgE are determined by YAMASA's ELISA kit and other Ig subtypes are measured by an Ig ELISA KIT (Rougier Bio-tech's, Montreal, Canada). Proteins that regulate IgD downstream signaling and Ig class switching can be evaluated.

- 15 3. Tests for activity of monocytes/macrophages are used to evaluate agents that modulate the expression or activity of signalling molecules, transcription factors.

*Mouse LPS-induced TNF- $\alpha$  production model:*

20 Compound is administered to BALB/c mice by intraperitoneal injection and one hour later the mice given LPS (200  $\mu$ g/mouse) by intraperitoneal injection. Blood is collected 90 minutes after the LPS injection and plasma is obtained. TNF- $\alpha$  concentration in the sample is determined using an ELISA kit. Proteins that regulate downstream effects of LPS stimulation, such as NF- $\kappa$ B activation, can be evaluated.

- 25 4. Tests for activity of eosinophils are used to evaluate agents that modulate the expression or activity of the eotaxin receptor, signaling molecules, cytoskeletal molecules, or adhesion molecules.
- 30

*Mouse eotaxin-induced eosinophilia model:*

BALB/c mice are injected intradermally with a 2.5 ml of air on days -6 and -3 to prepare an airpouch. On day 0, compound is administered intraperitoneally, and 30 minutes later, IL-5 (300 ng/mouse) is injected intravenously. After an additional 30 minutes, eotaxin is injected (3 µg/mouse, i.d.). Four hours after the eotaxin injection, leukocytes in the airpouch exudate are collected and the number of total cells is counted. Differential cell counts in the exudate are performed by staining with May-Grunwald Gimsa solution. Proteins that regulate signaling by the eotaxin receptor or regulate eosinophil trafficking can be evaluated.

## 5. Passive cutaneous anaphylaxis (PCA) test in rats

6 Weeks old male Wistar rats are sensitized intradermally (i.d.) on their shaved backs with 50 µl of 0.1 µg/ml mouse anti-DNP IgE monoclonal antibody (SPE-7) under a light anesthesia. After 24 hours, the rats are challenged intravenously with 1 ml of saline containing 0.6 mg DNP-BSA (30) (LSL CO., LTD) and 0.005 g of Evans blue. Compounds are injected intraperitoneally (i.p.) 0.5 hr prior to antigen injection. Rats without the sensitization, challenge, and compound treatment are used as a control and rats with sensitization, challenge and vehicle treatment are used to determine the value without inhibition. Thirty minutes after the challenge, the rats are sacrificed, and the skin of the back is removed. Evans blue dye in the skin is extracted in formamide overnight at 63°C. Absorbance at 620 nm is then measured to obtain the optical density of the leaked dye.

Percent inhibition of PCA with a compound is calculated as follows:

$$\% \text{ inhibition} = \{(\text{mean vehicle value} - \text{sample value}) / (\text{mean vehicle value} - \text{mean control value})\} \times 100$$



Proteins that regulate mast cell degranulation, vascular permeability, or receptor antagonists against histamine receptors, serotonin receptors, or cysteinyl leukotriene receptors can be evaluated.

5

6. *Anaphylactic bronchoconstriction in rats*

6 Weeks old male Wistar rats are sensitized intravenously (i.v.) with 10 µg mouse anti-DNP IgE, SPE-7, and 1 days later, the rats are challenged intravenously with 0.3 ml of saline containing 1.5 mg DNP-BSA (30) under anesthesia with urethane (1000 mg/kg, i.p.) and gallamine (50 mg/kg, i.v.). The trachea is cannulated for artificial respiration (2 ml/stroke, 70 strokes/min). Pulmonary inflation pressure (PIP) is recorded through a side-arm of the cannula connected to a pressure transducer. Changes in PIP reflect a change of both resistance and compliance of the lungs. To evaluate a compound, the compound is given i.v. 5 min before challenge.

15

Proteins that regulate mast cell degranulation, vascular permeability or receptor antagonists against histamine receptors, serotonin receptors, or cysteinyl leukotriene receptors can be evaluated. Proteins that regulate the contraction of smooth muscle can be also evaluated.

20

7. *T cell adhesion to smooth muscle cells or endothelial cells*

A purified population of T cells is prepared by ficoll density centrifugation followed by separation on a nylon wool column, rosetting with sheep red blood cells, or using magnetic beads coated with antibodies. The T cells are activated with mitogen for 36 to 42 hours and labeled with <sup>3</sup>H-thymidine during the last 16 hours of the activation. Airway smooth muscle cells or bronchial microvascular endothelial cells are obtained from lung transplant tissue, from bronchus resections from cancer patients, from cadavers, or as

25

30

cell lines from commercial sources. If fresh tissue is used as the source of cells, the smooth muscle cells and endothelial cells can be isolated from tissue by dissection followed by digestion for 30-60 minutes in a solution containing 1.7 mM ethyleneglycol-bis-(beta-aminoethylether)-N,N,N',N'-tetraacetic acid, 640 U/ml collagenase, 10 mg/ml soybean trypsin inhibitor, and 10 U/ml elastase. The smooth muscle cells or endothelial cells are grown in 24-well tissue culture dishes until confluent and then treated with a test compound and inflammatory mediators, such as TNF- $\alpha$  for 24 hours. To measure adhesion,  $6 \times 10^5$  T cells are added per well and allowed to adhere for one hour at 37°C. Nonadherent cells are removed by washing six times gently with medium. Finally, the remaining adherent cells are lysed by adding 300  $\mu$ l 1% Triton-X 100 in PBS to each well and quantitating the radioactivity in a scintillation counter. The percent binding is calculated as counts recovered from adherent cells/total input counts x 100%

CLAIMS

1. An isolated polynucleotide encoding a phospholipase A2-like enzyme polypeptide and being selected from the group consisting of:

5

- a) a polynucleotide encoding a phospholipase A2-like enzyme polypeptide comprising an amino acid sequence selected from the group consisting of:

10

amino acid sequences which are at least about 51 % identical to the amino acid sequence shown in SEQ ID NO: 2;

the amino acid sequence shown in SEQ ID NO: 2;

amino acid sequences which are at least about 51 % identical to the amino acid sequence shown in SEQ ID NO: 4;

15

the amino acid sequence shown in SEQ ID NO: 4;

amino acid sequences which are at least about 51 % identical to the amino acid sequence shown in SEQ ID NO: 9; and

the amino acid sequence shown in SEQ ID NO: 9;

20

- b) a polynucleotide comprising the sequence of SEQ ID NO: 1, 3 or 8;

- c) a polynucleotide which hybridizes under stringent conditions to a polynucleotide specified in (a) and (b);

25

- d) a polynucleotide the sequence of which deviates from the polynucleotide sequences specified in (a) to (c) due to the degeneration of the genetic code; and

30

- e) a polynucleotide which represents a fragment, derivative or allelic variation of a polynucleotide sequence specified in (a) to (d).

2. An expression vector containing any polynucleotide of claim 1.
3. A host cell containing the expression vector of claim 2.
- 5 4. A substantially purified phospholipase A2-like enzyme polypeptide encoded by a polynucleotide of claim 1:
5. A method for producing a phospholipase A2-like enzyme polypeptide, wherein the method comprises the following steps:
  - 10 a) culturing the host cell of claim 3 under conditions suitable for the expression of the phospholipase A2-like enzyme polypeptide; and
  - b) recovering the phospholipase A2-like enzyme polypeptide from the  
15 host cell culture.
6. A method for detection of a polynucleotide encoding a phospholipase A2-like enzyme polypeptide in a biological sample comprising the following steps:
  - 20 a) hybridizing any polynucleotide of claim 1 to a nucleic acid material of a biological sample, thereby forming a hybridization complex; and
  - b) detecting said hybridization complex.
- 25 7. The method of claim 6, wherein before hybridization, the nucleic acid material of the biological sample is amplified.
8. A method for the detection of a polynucleotide of claim 1 or a phospholipase A2-like enzyme polypeptide of claim 4 comprising the steps of:

contacting a biological sample with a reagent which specifically interacts with the polynucleotide or the phospholipase A2-like enzyme polypeptide.

9. A diagnostic kit for conducting the method of any one of claims 6 to 8.

5

10. A method of screening for agents which decrease the activity of a phospholipase A2-like enzyme, comprising the steps of:

10

contacting a test compound with any phospholipase A2-like enzyme polypeptide encoded by any polynucleotide of claim 1;

15

detecting binding of the test compound to the phospholipase A2-like enzyme polypeptide, wherein a test compound which binds to the polypeptide is identified as a potential therapeutic agent for decreasing the activity of a phospholipase A2-like enzyme.

11. A method of screening for agents which regulate the activity of a phospholipase A2-like enzyme, comprising the steps of:

20

contacting a test compound with a phospholipase A2-like enzyme polypeptide encoded by any polynucleotide of claim 1; and

25

detecting a phospholipase A2-like enzyme activity of the polypeptide, wherein a test compound which increases the phospholipase A2-like enzyme activity is identified as a potential therapeutic agent for increasing the activity of the phospholipase A2-like enzyme, and wherein a test compound which decreases the phospholipase A2-like enzyme activity of the polypeptide is identified as a potential therapeutic agent for decreasing the activity of the phospholipase A2-like enzyme.

30

12. A method of screening for agents which decrease the activity of a phospholipase A2-like enzyme, comprising the steps of:

5 contacting a test compound with any polynucleotide of claim 1 and detecting binding of the test compound to the polynucleotide, wherein a test compound which binds to the polynucleotide is identified as a potential therapeutic agent for decreasing the activity of phospholipase A2-like enzyme.

- 10 13. A method of reducing the activity of phospholipase A2-like enzyme, comprising the steps of:

15 contacting a cell with a reagent which specifically binds to any polynucleotide of claim 1 or any phospholipase A2-like enzyme polypeptide of claim 4, whereby the activity of phospholipase A2-like enzyme is reduced.

14. A reagent that modulates the activity of a phospholipase A2-like enzyme polypeptide or a polynucleotide wherein said reagent is identified by the method of any of the claim 10 to 12.

- 20 15. A pharmaceutical composition, comprising:  
the expression vector of claim 2 or the reagent of claim 14 and a pharmaceutically acceptable carrier.

- 25 16. Use of the expression vector of claim 2 or the reagent of claim 14 to produce a medicament for modulating the activity of a phospholipase A2-like enzyme in a disease.

- 30 17. Use of claim 16 wherein the disease is asthma, cancer, inflammation, CNS disorder, cardiovascular disorder, chronic obstructive pulmonary disease, diabetes, or obesity.

18. A cDNA encoding a polypeptide comprising the amino acid sequence shown in SEQ ID NOS:2, 4 or 9.
19. The cDNA of claim 18 which comprises SEQ ID NOS:1, 3 or 8.
- 5 20. The cDNA of claim 18 which consists of SEQ ID NOS:1, 3 or 8.
21. An expression vector comprising a polynucleotide which encodes a polypeptide comprising the amino acid sequence shown in SEQ ID NOS:2, 4 or 9.
- 10 22. The expression vector of claim 21 wherein the polynucleotide consists of SEQ ID NOS:1, 3 or 8.
- 15 23. A host cell comprising an expression vector which encodes a polypeptide comprising the amino acid sequence shown in SEQ ID NOS:2, 4 or 9.
24. The host cell of claim 23 wherein the polynucleotide consists of SEQ ID NOS:1, 3 or 8.
- 20 25. A purified polypeptide comprising the amino acid sequence shown in SEQ ID NOS:2, 4 or 9.
26. The purified polypeptide of claim 25 which consists of the amino acid sequence shown in SEQ ID NOS:2, 4 or 9.
- 25 27. A fusion protein comprising a polypeptide having the amino acid sequence shown in SEQ ID NOS:2, 4 or 9.
- 30 28. A method of producing a polypeptide comprising the amino acid sequence shown in SEQ ID NOS:2, 4 or 9 comprising the steps of:

culturing a host cell comprising an expression vector which encodes the polypeptide under conditions whereby the polypeptide is expressed; and

5 isolating the polypeptide.

29. The method of claim 28 wherein the expression vector comprises SEQ ID NOS:1, 3 or 8.

10 30. A method of detecting a coding sequence for a polypeptide comprising the amino acid sequence shown in SEQ ID NOS:2, 4 or 9 comprising the steps of:

15 hybridizing a polynucleotide comprising 11 contiguous nucleotides of SEQ ID NOS:1, 3 or 8 to nucleic acid material of a biological sample, thereby forming a hybridization complex; and detecting the hybridization complex.

31. The method of claim 30 further comprising the step of amplifying the nucleic acid material before the step of hybridizing.

20 32. A kit for detecting a coding sequence for a polypeptide comprising the amino acid sequence shown in SEQ ID NOS:2, 4 or 9 comprising:

a polynucleotide comprising 11 contiguous nucleotides of SEQ ID NOS:1, 3 or 8; and instructions for the method of claim 30.

25

33. A method of detecting a polypeptide comprising the amino acid sequence shown in SEQ ID NOS:2, 4 or 9 comprising the steps of:

30 contacting a biological sample with a reagent that specifically binds to the polypeptide to form a reagent-polypeptide complex; and detecting the reagent-polypeptide complex.



34. The method of claim 33 wherein the reagent is an antibody.

35. A kit for detecting a polypeptide comprising the amino acid sequence shown  
5 in SEQ ID NOS:2, 4 or 9 comprising:

an antibody which specifically binds to the polypeptide; and

instructions for the method of claim 33.

10 36. A method of screening for agents which can modulate the activity of a human phospholipase A2-like enzyme, comprising the steps of:

15 contacting a test compound with a polypeptide comprising an amino acid sequence selected from the group consisting of: (1) amino acid sequences which are at least about 51% identical to the amino acid sequence shown in SEQ ID NOS:2, 4 or 9 and (2) the amino acid sequence shown in SEQ ID NOS:2, 4 or 9; and

20 detecting binding of the test compound to the polypeptide, wherein a test compound which binds to the polypeptide is identified as a potential agent for regulating activity of the human phospholipase A2-like enzyme.

25 37. The method of claim 36 wherein the step of contacting is in a cell.

38. The method of claim 36 wherein the cell is *in vitro*.

39. The method of claim 36 wherein the step of contacting is in a cell-free system.

30 40. The method of claim 36 wherein the polypeptide comprises a detectable label.

41. The method of claim 36 wherein the test compound comprises a detectable label.
- 5 42. The method of claim 36 wherein the test compound displaces a labeled ligand which is bound to the polypeptide.
43. The method of claim 36 wherein the polypeptide is bound to a solid support.
- 10 44. The method of claim 36 wherein the test compound is bound to a solid support.
45. A method of screening for agents which modulate an activity of a human phospholipase A2-like enzyme, comprising the steps of:
- 15 contacting a test compound with a polypeptide comprising an amino acid sequence selected from the group consisting of: (1) amino acid sequences which are at least about 51% identical to the amino acid sequence shown in SEQ ID NOS:2, 4 or 9 and (2) the amino acid sequence shown in SEQ ID
- 20 NO:2, 4 or 9; and detecting an activity of the polypeptide, wherein a test compound which increases the activity of the polypeptide is identified as a potential agent for increasing the activity of the human phospholipase A2-like enzyme, and wherein a test compound which decreases the activity of the
- 25 polypeptide is identified as a potential agent for decreasing the activity of the human phospholipase A2-like enzyme.
46. The method of claim 45 wherein the step of contacting is in a cell.
47. The method of claim 45 wherein the cell is *in vitro*.

48. The method of claim 45 wherein the step of contacting is in a cell-free system.
49. A method of screening for agents which modulate an activity of a human phospholipase A2-like enzyme, comprising the steps of:
- 5       contacting a test compound with a product encoded by a polynucleotide which comprises the nucleotide sequence shown in SEQ ID NOS:1, 3 or 8; and
- 10       detecting binding of the test compound to the product, wherein a test compound which binds to the product is identified as a potential agent for regulating the activity of the human phospholipase A2-like enzyme.
50. The method of claim 49 wherein the product is a polypeptide.
- 15       51. The method of claim 49 wherein the product is RNA.
52. A method of reducing activity of a human phospholipase A2-like enzyme, comprising the step of:
- 20       contacting a cell with a reagent which specifically binds to a product encoded by a polynucleotide comprising the nucleotide sequence shown in SEQ ID NOS:1, 3 or 8, whereby the activity of a human phospholipase A2-like enzyme is reduced.
- 25       53. The method of claim 52 wherein the product is a polypeptide.
54. The method of claim 53 wherein the reagent is an antibody.
- 30       55. The method of claim 52 wherein the product is RNA.

56. The method of claim 55 wherein the reagent is an antisense oligonucleotide.
57. The method of claim 56 wherein the reagent is a ribozyme.
- 5 58. The method of claim 52 wherein the cell is *in vitro*.
59. The method of claim 52 wherein the cell is *in vivo*.
60. A pharmaceutical composition, comprising:
- 10 a reagent which specifically binds to a polypeptide comprising the amino acid sequence shown in SEQ ID NOS:2, 4 or 9; and
- a pharmaceutically acceptable carrier.
- 15 61. The pharmaceutical composition of claim 60 wherein the reagent is an antibody.
62. A pharmaceutical composition, comprising:
- 20 a reagent which specifically binds to a product of a polynucleotide comprising the nucleotide sequence shown in SEQ ID NOS:1, 3 or 8; and
- a pharmaceutically acceptable carrier.
- 25 63. The pharmaceutical composition of claim 62 wherein the reagent is a ribozyme.
64. The pharmaceutical composition of claim 62 wherein the reagent is an
- 30 antisense oligonucleotide.

65. The pharmaceutical composition of claim 62 wherein the reagent is an antibody.
66. A pharmaceutical composition, comprising:
- 5 an expression vector encoding a polypeptide comprising the amino acid sequence shown in SEQ ID NOS:2, 4 or 9; and
- a pharmaceutically acceptable carrier.
- 10 67. The pharmaceutical composition of claim 66 wherein the expression vector comprises SEQ ID NOS:1, 3 or 8.
68. A method of treating a phospholipase A2-like enzyme disfunction related disease, wherein the disease is selected from asthma, cancer, inflammation, a
- 15 CNS disorder, a cardiovascular disorder, chronic obstructive pulmonary disease, diabetes, or obesity comprising the step of:
- administering to a patient in need thereof a therapeutically effective dose of a
- 20 reagent that modulates a function of a human phospholipase A2-like enzyme, whereby symptoms of the phospholipase A2-like enzyme disfunction related disease are ameliorated.
69. The method of claim 68 wherein the reagent is identified by the method of
- 25 claim 36.
70. The method of claim 68 wherein the reagent is identified by the method of claim 45.
71. The method of claim 68 wherein the reagent is identified by the method of
- 30 claim 49.

Fig. 1

gaggcctcta	cctgctggca	gctcacagt	agggtcctgg
aggcgcgga	cctgcgctgg	gctgacctgt	tgagtgaggc
cgacccttac	gtgatcctac	agctgtcgac	cgcacctgga
atgaagttta	agaccaagac	gctcacegac	accagtcac
ctgtgtggaa	tgaggccttc	cgtttcctta	tccaaagtca
ggtcaagaat	gttctggagc	ttagcatcta	tgatgaggac
tcagtcacgg	aggatgacat	ctgcttcaag	gttctctatg
acatctcaga	agtccctccct	ggcaagctgc	tccggaaaac
cttctcccag	agtccccagg	gagaggagga	gctggatgtg
gagttcctga	tggaagaaac	gtcagatcgc	ccagaaaacc
tcatcaccaa	caaagtcatt	gtggcccag	agctgtcatg
cctggatgtg	catctggaca	gcacaggag	caccgctgtg
gttgagatc	aggacaagct	ggagctggag	ctgggtgctga
aggggtccta	tgaggacaca	cagacatcct	tcctgggcag
agcctctgcc	ttccgcttcc	actacatggc	agccctagag
acagagatga	gcgggcgcct	gaggagctcc	agaagcaatg
gctggaatgg	ggacaactca	gctgggtacc	tactgtgcc
cctgaggccc	ttgaccattg	ggaaggaggt	gactatggat
gttcctgctc	caaagtcccc	aggagtgagg	ctgcagctca
aggcagaggg	ctgccctgag	gagctggccg	tgacacctggg
cttcaatctc	tgtgcagagg	agcaggcctt	cctgagcagg
aggaagcagg	tggtggccaa	ggccctgaag	caggccctgc
agctggacag	agacctgcag	gaggatgagg	taccctgtgt
gggcatcatg	gccacaggag	gaggtgcccg	ggccatgacc
tactctacg	gccacctatt	ggccttgag	aagctgggccc
tcctagactg	tgtgacctac	ttcagtggca	tctctggctc
tacgtggaca	atggcccacc	tgtacgggga	ccctgagtgg
tcgcagaggg	acctggaggg	acctatcaga	tacgcccggg
agcacctggc	caagagcaag	ctggaggtct	tttccccaga
gcgcctggcg	agctaccgcc	gggagctgga	gctgcgggct
gagcagggcc	accccacgac	ctttgtggac	ctgtggggcg
tagtgctgga	gtccatgctg	cacggccag	

Fig. 2

EASTCWQLTV	RVLEARNLRW	ADLLSEADPY	VILQLSTAPG
MKFKTKTLTD	TSHPVWNEAF	RFLIQSQVKN	VLELSIYDED
SVTEDDICFK	VLYDISEVLP	GKLLRKTFSQ	SPQGEEELDV
EFLMEETSDR	PENLITNKVI	VARELSCLDV	HLDSTGSTAV
VADQDKLELE	LVLKGSYEDT	QTSFLGTASA	FRFHYMAALE
TELSGRLRSS	RSNGWNGDNS	AGYLTVPLRP	LTIGKEVTMD
VPAPNAPGVR	LQLKAEGCPE	ELAVHLGFNL	CAEEQAFLSR
RKQVVAKALK	QALQLDRDLQ	EDEVPVVGIM	ATGGGARAMT
SLYGHLLALQ	KLGLLD CVTY	FSGISGSTWT	MAHLYGDPEW
SQRDLEGPIR	YAREHLAKSK	LEVFSPERLA	SYRRELELRA
EQGHPTTFVD	LWALVLESML	HGQ	

Fig. 3

gatcagaagc	tgctcaggaca	gagagccgcc	ctggaacggg
gtcagaaccc	tctgcccctc	tacttgagcc	tcaatgtcaa
agagaacaat	ctggagacac	tggacttcaa	ggagtggggt
gagttctccc	cctatgaggt	cggtttcctg	aagtacgggg
ccttcgtccc	tcttgagctc	ttcggctccg	agttcttcat
gggacggctg	atgaggagga	tcccggagcc	ccggatctgc
tttctggaag	ccatctggag	caacattttc	tccctgaacc
tgtctggatg	ctggtatgac	ctcaccagtt	ctggggagtc
ctggaaacag	cacatcaagg	acaagaccag	gagcttagag
aaggagcccc	tgaccacctc	ggggacctcc	tgcgggctgg
aggcctcgtg	gctgcagcca	ggcacggcgc	tggcccaggc
atttaaaggc	ttcctgacag	gcaggccctc	ccaccagcgc
agccccaact	tcctccaggg	cctccagctg	caccaggact
actgtagcca	caaagacttc	tccacctgg	

Fig. 4

DQKLSGQRAA	LERGQNPLPL	YLSLNVKENN	LETLDKFKEWV
EFSPYEVGFL	KYGAFVPPEL	FGSEFFMGRL	MRRIPPEPRIC
FLEAIWSNIF	SLNLLDAWYD	LTSSGESWKQ	HIKDKTRSLE
KEPLTTSCTS	SRLEASWLQP	GTALAQAFKG	FLTGRPLHQR
SPNFLOGLQL	HQDYCSHKDF	STW	

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Fig. 5

MSNIIVEHQYSHRLKLTVVRAENVTKGAFGDLDLTPDPYVELSVPTTP  
ESRKTRRHINNDINPKWNETFEFILDPNQSNVLEVTLMMDANYVMDETL  
GTAKYSLSKLKVAQMEHVTLSIGKTTKVFLDLLEVCASDRLRFSMTL  
CDQEKLFMQTRDRVMLSIIKKLLKMNPRFLPSSPREVPTIAILGSGG  
GFRAMVGFSGVMKALYESGVFDCATYVAGLSGSTWYMSMLYSHPEFPA  
KGP GDINKELMNRVSNPLKLLPQNINRYVKALWKKKSAGQPVFTFD  
IFGMLIGETLIPGRMNIKLSSLKGKINEGQSPLPLFTCLHVKPDVSEL  
MFADWVEFSPYEIGMAKYGTfMSPGLFGSKFFMGSSVVKQYEENPLHFL  
MGVWGSAFSILFNRVLGVKETTSSSTMEEELEQIKPEHIVGDDSDADNE  
EETQRGGTESADAEDERQORHAQASWVQRMLTSIMGDTTLFTTREGRAG  
KVHNFMLGLNLNSTLFPSPFGSITHQTSLEEEVDVAVTDPDEFERIYEP  
LDVKSCKIHVVD SGLTFNLPYPLILRCQRGVDLIISFDFSARPSDSSP  
PFKELLLAEKWARMNKLPFPKIDSKVFDREGLKECYVFKPAKGDKNCP  
TIIHFVLANINFRNFKAPGVPRDSKDIEFGDFDIFDEPASPYSTFNF  
KYNNQAFKRLHDLMEFNTLNNIEVIKEAIKDSILLRRENPARCSVSLS  
LSEIENKKFLKRDNSIAKRPT

Fig. 6

msfidpyqhiivvehqyshvftvtvrkatnvtkgaigdmldtpdpyvel  
fipsapdcrrtkrhfnndvnpvwnetfefeildpnqdnvlevtlmdany  
vmdetlgmatfpissklgekkevqltfnnvtentlelslevcsstdl  
rfsmalcdeekfrqqrkdnmqsmksflgeensknlttsrdvpvia  
lgsgggfframvgfagvmkalyesgvldcatyiaglsgstwymstlysh  
pdfpekgpkeingelmnsvsnhplllltpqkvkryiealwnkkssgqp  
vtftdifgmligetlihnrmddtlldmkekvseaqcalplftclhvkp  
dvselmfadwvefspyeygmakygtfmspdllfgskffmgstvvkkysen  
plhflmgvwsafsilfnrvlgvsnsqngkptmeeelenirklhlvs  
dssdsedesqhpkg tenseaneeyqnssqeswvqrmlmalvgdsalfn  
tregragkvhnfmlglnlncypplspladlltqesveedeldaavadp  
deferiyepldvksckihivdsgltfnlpyplilrpqrgvdliisfdf  
sarpsdssppfkeillaekwakmnklpfpkidpnvfdreglkecyvfk  
pkdtssekdcptiihfvlaninfrkykapglpreskeekdfadfdifd  
dpntpfstfnfqypneafkrlhdlmefntlnnldvikqammesieyrk  
enpsrcsvslssvearrffnknnlnnht



Fig. 7

msniivehqyshrlkltvvraenvtkgafgdllldtpdpyvelsvpttp  
esrkrtrhinndinpkwnetfefildpnqsnvlevtlmdanyvmdetl  
gtakyslsklkvaqmehvtlsigkttkvfldlillevcastdlrfsmtl  
cdqeklfmqtrrrdrvmlsikkllkmenprflpssprevptiaailgsgg  
gframvgfsgvmkalyesgvfdcatyvaglsgstwymsmlyshpefpa  
kgpgdinkelmnrvsnnpklklpqninryvkalwkkksagqpvtftd  
ifgmligetlipgrmniklsslkgkineggsplplftclhvkpdsel  
mfadwvefspyeigmakytgfm spglfgskffmgsvvkqyeenplhfl  
mgvwgsafsilfnrvlgvkettssstmeeeleqikpehivgddsadne  
eetqrggtesadaederqrhaqaswvqrmltsimgdttlfttregrag  
kvhnfmlglnlnstlpfspfsgithqtsleeevdavtdpdeferiyep  
ldvkskkihvvdsghltfnlpyplilrcqrgvdliisfdfsarpsdssp  
pfkelllaekwarmnklpfpkidskvfdreglkecyvfkpakgdkncp  
tiihfvlaniinfrnfkapgvprdsdkdiefgdfdifdepaspystfnf  
kynnqafkrlhdlmefntlnnievikeaikdsillrrenparcsvsls  
lseienkkflkrdnsiakrpt

Fig. 8

gaggcctctacctgctggcagctcacagtgagggctcctggaggcgcg  
aacctgcgctgggctgacctgttgagtgaggccgaccttacgtgatc  
ctacagctgtcgaccgcacctggaatgaagttaagaccaagacgctc  
accgacaccagtcacctgtgtggaatgaggccttcggtttccttate  
caaagtcagggtcaagaatgttctggagcttagcatctatgatgaggac  
tcagtcacggaggatgacatctgcttcaagggttctctatgacatctca  
gaagtcctccctggcaagctgctccgaaaaccttctcccagagtc  
cagggagaggaggagctggatgtggagttcctgatggaagaaacgtca  
gatcgcccagaaaacctcatccaacaaagtcattgtggcccgagag  
ctgtcatgcctggatgtgcatctggacagcacagggagcacctgtgtg  
gttgacagatcaggacaagctggagctggagctggtgctgaaggggtcc  
tatgaggacacacagacatccttccctgggcacagcctctgccttccgc  
ttccactacatggcagccctagagacagagctgagcggggcgctgagg  
agctccagaagcaatggctggaatggggacaactcagctgggtacctc  
actgtgcccctgaggcccttgaccattgggaaggaggtgactatggat  
gttccctgctccaaatgccccaggagtgaggctgcagctcaaggcagag  
ggctgcccctgaggagctggccgtgcacctgggcttcaatctctgtgca  
gaggagcaggccttccctgagcaggaggaagcaggtgggtggccaaggcc  
ctgaagcaggccctgcagctggacagagacctgcaggaggatgaggta  
ccggttggtgggcatcatggccacaggaggaggtgcccggggccatgacc  
tcactctacggccacctattggccttgcaagagctgggcctcctagac  
tgtgtgacctacttcagtggcatctctggctctacgtggacaatggcc  
cacctgtacggggaccctgagtggctcgagagggacctggagggacct  
atcagatacgcccgggagcacctggccaagagcaagctggagggtcttt  
tccccagagcgccctggcgagctaccgcccgggagctggagctgcgggt  
gagcaggggccaccccacgacctttgtggacctgtggggcgctagtgtg  
gagtccatgctgcacggccaggtgatggatcagaagctgtcaggacag  
agagccgcccctggaacggggtcagaacctctgcccctctacttgagc  
ctcaatgtcaaagagaacaatctggagacactggacttcaaggagtgg  
gttgagttctccccctatgagggtcggtttcctgaagtacggggccttc  
gtccctcctgagctcttcggctccgagttcttcatgggacggctgatg  
aggaggatcccggagccccggatctgctttctggaagccatctggagc  
aacattttctccctgaacctgctggatgcctggatgacctcaccagt  
tctggggagtcctggaaacagcacatcaaggacaagaccaggagctta  
gagaaggagccccctgaccacctcggggacctcctcgcggtggaggcc  
tcgtggctgcagccaggcacggcgtggcccaggcatttaaggcttc  
ctgacaggcaggccccctccaccagcgcagcccccaacttccctccagggc  
ctccagctgcaccaggactactgtagccacaaagacttctccacctgg  
gcagactaccagcttgactccatgcccagccagctgacccccaggag  
ccccggctctgcctgggtggacgcccgtacttcatcaacaccagctct  
ccctccatgttccggccaggccgaggtggacctcatcctctccttc  
gactactccctatctgcgccccttcgaggcactgcagcagacggagctg  
tactgcccggggccgggggtgcccttccccgggtggaacccagccct  
caggaccagcaccagccaagggaatgccacctcttctcagacccccgcc

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tgccccgaggccccgatcctgctgcacttcccgctggtcaatgcctcc  
ttcaaggaccactcagcccccggtgtccagcgcagccccgcagagctc  
caggggtggccaagtggatctcaccggggccacctgcccctacaccctg  
tccaacatgacctacaaggaggaagacttcgagcgcctgctgcggctc  
agtgactacaacgtgcagaccagccaggggtgccatcctgcaggccctg  
aggaccgcgctgaagcaccggactctagaggcgaggcctccaagggca  
cagacctga

Fig. 9

EASTCWQLTV	RVLEARNLRW	ADLLSEADPY	VILQLSTAPG
MKFKTKTLTD	TSHPVWNEAF	RFLIQSQVKN	VLELSIYDED
SVTEDDICFK	VLYDISEVLP	GKLLRKTF SQ	SPQGEELDV
EFLMEETSDR	PENLITNKVI	VARELSCLDV	HLDSTGSTAV
VADQDKLELE	LVLKGSYEDT	QTSFLGTASA	FRFHMAALE
TELSGRLRSS	RSNGWNGDNS	AGYLTVPLRP	LTIGKEVTMD
VPAPNAPGVR	LQLKAEGCPE	ELAVHLGFNL	CAEEQAFLSR
RKQVVAKALK	QALQLDRDLQ	EDEVPPVGIM	ATGGGARAMT
SLYGHLLALQ	KLGLLDCVTY	FSGISGSTWT	MAHLYGDPEW
SQRDLEGPIR	YAREHLAKSK	LEVFSPERLA	SYRRELELRA
EQGHPTTFVD	LWALVLESML	HGQVMDQKLS	GQRAALERGQ
NPLPLYLSLN	VKENNLETLD	FKEWVEFSPY	EVGFLKYGAF
VPPELFGSEF	FMGRLMRRIP	EPRICFLEAI	WSNIFSLNLL
DAWYDLTSSG	ESWKQHIKDK	TRSLEKEPLT	TSGTSSRLEA
SWLQPGTALA	QAFKGFLTGR	PLHQSPNFL	QGLQLHQDYC
SHKDFSTWAD	YQLDSMPSQL	TPKEPRLCLV	DAAYFINTSS
PSMFRPGRRL	DLILSFDYSL	SAPFEALQQT	ELYCRARGLP
FPRVEPSPQD	QHQPRechLF	SDPACPEAPI	LLHFPLVNAS
FKDHSAPGVQ	RSPAELQGGQ	VDLTGATCPY	TLSNMTYKEE
DFERLLRLSD	YNVQTSQGAI	LQALRTALKH	RTLEARPPRA QT

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Fig. 10

BLASTP - alignment of 364 1 protein against trembl|AF065215|AF065215\_1  
 gene: "cPLA2 beta"; product: "cytosolic phospholipase A2 beta"; Homo sapiens  
 cytosolic phospholipase A2 beta (cPLA2 beta) mRNA, complete cds.  
 This hit is scoring at : 5e-108 (expectation value)  
 Alignment length (overlap) : 425  
 Identities : 50 %

Scoring matrix : BLOSUM62 (used to infer consensus pattern)  
 Database searched : nrdb

```

Q: 1 EASTCWQLTVRVLEARNLRWADLLSEADPYVILQLSTAPGMKFKTKTLTDTSHPVWNEAF
   E.S.. LTVRVL:A..L .DL:::D YV.L L.TA .::T:T:::S.PVWN::F
H: 236 EVSRTCLITVRVLQAHLRPSKDLVTPSDCYVTLMPLTACSHRLQTRTVKNSSSPVWNQSF

REFLIQSQVKNVLELSIYDEDSVTEDDICFKVLYDISEVLPGLKLRKTFSSPQGEELDV
.F I..Q:KNV:EL::D:D VT DD ...VL:D...:G: R::FS SPQGE .L:V
HFRIHRQLKNVMELKVFDQDLVTGDDPVLVLFDAITLRAGEFRRESFSLSPQGEGRLEV

EFLMEETSDRPNLITNKVIVARELSCLDVHLDSTGSTAVVADQDKLE--LELVKGSYE
EF ::::DR E L:N V:VARELSCL.V.L: TG DQ.. E :LV:GS E
EFRLQSLADRGEWLVNGLVARELSCLHVQLEETG-----DQKSEHRVQLVVPGSCE

DTQTSFLGTASAFRFHYMAALETELSGRLRSSRNGWNGDNSAGYLTVPRLPLTIGKEVT
..Q.:GT.:FRFH A.E.ELS RL: D..L..PL..L. G: V.
GPQEASVGTGT-FRFHCPACWEQELSIRLQ-----DAPEEQLKAPLSALPSGQVVR

MDVPAPNAPGVRLQLKAECCPEELAVHLGFNLCAEEQAFLSRRKQVVAKALKQALQLDRD
: P....P :R:LK.E. .ELAV.LGF. CAEEQAFLSRRKQVVA.AL:QALQLD D
LVFPTSQEPLMRVELKKEAGLRELAVRLGFGPCAEEOAFLSRRKQVVAAALRQALQLDGD

LQDEVPVVGIMATGGGARAMTSLYGHLLALQKLGLLDCVTYFSGISGSTWTMAHLYGDP
LQEDE:PVV.IMATGGG.RAMTSLYG.L..L:LGLLDCV:Y:G.SGSTW:A:LY DP
LQEDEIPVVAIMATGGGIRAMTSLYGLAGLKLGLLDCVSYITGASGSTWALANLYEDP
  
```

Fig. 10 (continued)

· EWSQRDLEGPIRYAREHLAKSKLEVFSPERLASRRELELRAEQGHPTTFVDLWALVLES  
EWSQ:DL.GP.....K:KL V:P::L.YR:EL. RA.G:P:.F.:LWAL: E:  
EWSQKDLAGPTTELLKTQVTKNKLGVLAPSQLQRYRQELAERARLGYPCFTNLWALINEA

MLHGQ           423  
:LH.:  
LLHDE           644

BLASTP - alignment of 364\_1\_protein against swiss P49147 PA2Y CHICK

CYTOSOLIC PHOSPHOLIPASE A2 (CPLA2) [INCLUDES: PHOSPHOLIPASE A2 (EC 3.1.1.4) (CPLA2)  
(PHOSPHATIDYLCHOLINE 2-ACYLHYDROLASE); LYSOPHOSPHOLIPASE (EC 3.1.1.5)].  
//:trembl|U10329|GG10329\_1 product: "cytosolic phospholipase A2"; Gallus gallus  
cytosolic  
phospholipase A2 mRNA, complete cds.

This hit is scoring at : 4e-23 (expectation value)

Alignment length (overlap) : 210

Identities : 28 %

Scoring matrix : BLOSUM62 (used to infer consensus pattern)

Database searched : nrdb

```

Q: 218 DNSAGYLTVPLRPLTIGKEVTMDVPAPNAPGVRLQLKAEGCPEELAVHLGFNLCAEEQAF
H: D::G..T.P::L.G:::..N..:L:L..E C ...:.... LC EE::F
99 DETLGMATFPISSLKLGKEKVEQLTFNNVTMTLELSLEVC--SSTDLRFSMALCDEEKKF

LSRRKQVVAKALKQALQLDRDLQ---EDEVPVVGIMATGGGARAMTSLYGHLLALQKLGL
:RK:::K.L:::VPV:::GGG RAM...G:AL::G:
RQQRKDNIMQSMKSFLLGEENSKNLTTSRDVPVIAVLGSGGGFRAMVGFAGVMKALYESGV

```

LDCVTYFSGISGSTWMAHLYGDPESQDLEGPTRYAREHLAKSLVFSPERLASYRR  
LDC.TY.G:SGSTW M: LY.P::::: : ..... L ::P:::: Y .  
LDCATYIAGLSGSTWMSTLYSHPDFPEKGPKEINQELMNSVSHNPLLLLTPOKVRYIE

LELELRAEQGHPTTFVDLWALVL-ESMLHGQ 423  
L :...G.P.TF.D: : : : E: : H: :  
ALWNKKSSGQPVTFDIFGMLIGETLIHNR 307

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Fig. 12

HMMPFAM - alignment of 364\_1 protein against pfam|hmm|C2  
C2 domain

This hit is scoring at : 56.2

Scoring matrix : BLOSUM62 (used to infer consensus pattern)

```

Q:  8 LTVRVLEARNLRWAD-LLS-EADPYVILQLSTAPG--MKFKTKTLTDT--SHPVWN-EAF
    LTV.V:EARNL.D : . :DPYV :.L .KFKTK...T :PVWN E.F
H:  1 LtVtvieArnLpkmDkvngrlsDPYVkvslldgdkdlkfkTKvvkktNGLNPvWneEtF

    RFL--IQSQVKN-VLELSIYDEDSVTEDDICFKVL      92
    F : : : : .L : : : YDED...DD.. :V.
    vFekvplpelasktLrfavvYDedrfdrddfiGqvt      95
  
```





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Fig. 14

BLASTP - alignment of 364\_2 protein against swiss|P50392|PA2Y\_BRARE  
 CYTOSOLIC PHOSPHOLIPASE A2 (CPLA2) [INCLUDES: PHOSPHOLIPASE A2 (EC 3.1.1.4)  
 (CPLA2)  
 (PHOSPHATIDYLCHOLINE 2-ACYLHYDROLASE); LYSOPHOSPHOLIPASE (EC 3.1.1.5)]://:  
 trembl|U10330|BR10330.1 product: "cytosolic phospholipase A2"; Brachydanio  
 rerio cytosolic phospholipase A2 mRNA, complete cds.//:pironly|B54908|B54908  
 phospholipase A2 cytosolic - zebra fish//:gp|U10330|508627 product: "cytosolic  
 phospholipase A2"; Brachydanio rerio cytosolic phospholipase A2 mRNA, complete  
 cds.

This hit is scoring at : 6e-19 (expectation value)

Alignment length (overlap) : 188

Identities : 34 %

Scoring matrix : BLOSUM62 (used to infer consensus pattern)

Database searched : nrdb

Q: 3 KLSGQRAALERGNPLPLYLNLVKNLETLDFKEWVEFSPYEVGFLKYGAFVPPLEFG  
 KLS. :...GQ:PLPL:L:VK.: E.: F:WVEFSPYE:G.:KYG.F.:P LFG  
 H: 306 KLSSLKGINEGQSPPLPLFTCLHVKPDVSELM-FADWVEFSPYEIGMAKYGTFMSPGLFG  
 SEFFMGRLMRRIPPEPRICFLEAIWSNIFSL--NLLDWYDLTSSG-----ESWKQHIK  
 S:FFMG:....E.:FL.:W.:FS: N.: :TSS.: :HI  
 SKFFMGSVVKQYEENPLHFLMGVWGSAFSILFNRLGVKETTSSSTMEEELEQIKPEHIV  
 DKTRSLEKEPLTTSSTSS-----RLEASWLQPG-TALAAQAFKGLTGRPLHQRSPN  
 ....:..E.....GT.S ..:ASW:Q T:..: F.T.: N  
 GDDSADNEEETQRGGTESADAEDERQORHAQASWVQRMVLTSMGDTTLFTTREGRAKVVHN

FLQGLQLH 171  
 F: GL:L:  
 FMLGLNLN 492

Fig. 15

BLASTP - alignment of 364\_2\_protein against pdb|1CJY|1CJY-A

cytosolic phospholipase a2(cpla2)

This hit is scoring at : 3e-17 (expectation value)

Alignment length (overlap) : 168

Identities : 35 %

Scoring matrix : BLOSUM62 (used to infer consensus pattern)

Database searched : nrdb

```

Q:      4  LSGQAAALERGQNPLPLYLSLNVKENNLETLDKKEWVEFSPYEVGFLKYGAFFVPPPELFGS
      LS. :...Q PLPL:..L:VK.: E.: F.:WVEFSPYE:G..KYG.F.:P:LFGS
H:     300  LSSLKEKVNTAQCPPLPFTCLHVKPDVSELM-FADWVEFSPYEIGMAKYGTMAPDLFGS

      EEFMGRMLMRRIPERICFLEAIWSNIFSLNLLDAWYDLTSSGESWKQHIKDKTRSLKEKP
      :FFMG:.....E : FL :W:..FS:      :. : S      T.. E E
      KFFMGTVVKKYEENPLHFLMGVWGSAFSI-----LFNRVLS-----TMEEELEN

      LTTSGTSSRLASWL-QPGTALAQAQFKGFLTGRPLHQRSNPNFLQGLQL      170
      :TT..S.:ASW:..AL:..F T.:NF:GL.L
      ITTKHIVSNQASWIHRMIMALVSDSALFNTREGRAGKVHNFMLGLNL      450

```

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Fig. 16

BLASTP - alignment of 364 newProtein against trembl|AF065215|AF065215 1  
 gene: "cPLA2 beta"; product: "cytosolic phospholipase A2 beta"; Homo sapiens  
 cytosolic phospholipase A2 beta (cPLA2 beta) mRNA, complete cds.  
 //:gp|AF065215|3811347 gene: "cPLA2 beta"; product: "cytosolic phospholipase  
 A2 beta"; Homo sapiens cytosolic phospholipase A2 beta (cPLA2 beta) mRNA,  
 complete cds.

This hit is scoring at : 0.0 (expectation value)

Alignment length (overlap) : 795

Identities : 50 %

Scoring matrix : BLOSUM62 (used to infer consensus pattern)

Database searched : nrdb\_1;

```

Q: 1 EASTCWQLTVRVLEARNLRWADLLSEADPYVILQLSTAPGMKFKTKLTDTSHPVWNEAF
E.S.. LTVRVL:A..L .DL:::D YV.L L.TA .::T:T:::S.PVWN::F
H: 236 EVSRTCLLTVRVLOAHRLPKDLVTPSDCYVTLWLPTACSHRLQTRTVKNSSSPVWNQSF

      RFLIQSQVKNVLELSIYDEDSVTEDDICFKVLYDISEVLPGLKLRKTFQSPOGEEELDV
      .F I..Q:KNV:EL::D:D VT DD ..VL:D:::G:: R::FS SPOGE .L:V
      HFRIHRQLKNVMELKVFDQDLVTGDDPVLVLFDA GTLRAGEFRRESFSLSPQGEGRLEV

      EFLMEETSDRPNLITNKVIVARELSCLDVHLDSTGSTAVVADQDKLE--LELVLKGSYE
      EF ::::DR E L::N V:VARELSCL.V.L: TG DQ.. E ::LV:GS E
      EFRLQSLADRGEWLVSNGLVARELSCLHVQLEETG-----DQKSSEHRVQLVVPSCSE

      DTQTSFLGTASAFRFHYMAALETELSGRLRSSRNSGWNWDNSAGYLTVPPLRPLTIGKEVT
      ..Q.: :GT.: FRFH A. E.ELS RL: D ..L..PL..L. G: V.
      GPQEASVGTGT-FRFHCPACWEQELSIRLQ-----DAPEEQKAPLSALPSGQVVR

      MDVPAPNAPGVRLOLKAEGCPEELAVHLGFNLCAEEQAFLSRRKQVVAKALQALQDLD
      : .P...P :R::LK.E. .ELAV.LGF. CAEEQAFLSRRKQVVA.AL:QALQLD D
      LVFPTSQEPMLMRVELKKEAGLRELAVRIGFGPCAEEOAFLSRRKQVVAALRQALQDLDGD
      LQEDVPVVGIMATGGGARAMTSLYGHLLALQKLGLLDCVTFYFSGISGSTWTMAHLYGDP
      LQEDE:PVV.IMATGGG.RAMTSLY.G.L.L.:LGLLDCV:Y.:G.SGSTW.:A:LY DP
      LQEDEIPVVAIMATGGGIRAMTSLYQLAGLKLGLLDCVSYITGASGSTWALNIYEDP
  
```

Fig. 16 (continued)

EWSQDLEGP:IRYAREHLAKSKLEVFSPERLASRRELELRAEQGHPTTFVDIWLALVLES  
 EWSQ:DL.GP.....K:KL V:P:L.YR:EL. RA. G:P:F:LMAL: E:  
 EWSQKDLAGPTLTKTQVTKNKLGLVAPSQLRQYRQELAERARLGYPSCTNLWALINEA  
  
 MLHGQVMDQKLSQRAALERGONPLPLYLSLNVKNNLETILDFKEWVEFSPYEVGFLLKYG  
 :LH.: D.KLS. OR. AL.. GONPLP:Y:LN.K :L.T.:F EW.EFSPYEVGF KYG  
 LLHDEPHDKLSDQREALSHGONPLPIYCALNTKGQSLTTFEGWCECFSPYEVGFPPKYG  
  
 AFVPPLEFGSEFFMGRLMRRRIPEPRICFLEAIWSNIFSLNLLDAWYDLTSSGESWKQHIK  
 AF:P.ELFGSEFFMG:LM:R:PE. RICFLE. IWSN:::NL D: Y :..... W: :  
 AFIPSELFGEFFMGQMLMKRLPESRICFLEGIWSNLYAANLQDSLYWASEPSQFWDWRWVR  
  
 DKTRSLEKEPLTTSCTSSRLASWLOPGTA--LAQAFKGFILTCRPLHQRSNPNFLQGLQLH  
 :.:L:KE:.....P.TA :A:F...LT RPL Q.:NFL:GL..H  
 NQA-NLDKEQVPLLKIEE-----PPSTAGRIAEFFTDLLTWRPLAQATHNFRGLHFFH  
  
 QDYCSHKDFSTWADYQLDSMPQSOLTTPKEPRCLCLVDAAYFINTSSPSMFRPGRRRLDLISF  
 :DY.H..FSTW..LD.:P:QLTP.EP.LCL:D.Y.INTS. :.:P:R:DLILS.  
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 DY:L...F:LQ.:C:..G:PPF.:PSP:Q:QPRECH.FSDP.CP AP.:LHFFPL  
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 Q.:L:ALR.A:..R  
 QEQLLEALRQAVQRR 1006

- 16/16 -

Fig. 17 Expression profiling of human phospholipase A2-like enzyme mRNA, whole-body screen

Sample	Cell Name	Abs. #	Norm. #
Sample 1	Brain-1	165.1	185
Sample 2	Heart-3	.891	1
Sample 3	Kidney	4.544	5
Sample 4	Liver	2.569	7
Sample 5	Lung	94.86	181
Sample 6	Trachea	43.45	89
Sample 7	Bone Marrow-1	0	0
Sample 8	Colon	102.3	71
Sample 9	Small Intestine	41.82	55
Sample 10	Spleen-1	0	0
Sample 11	Stomach	0	0
Sample 12	Thymus-1	216.7	211
Sample 13	Mammary gland	33.16	49
Sample 14	Prostate-1	836.5	718
Sample 15	Skeletal muscle-1	10950	17448
Sample 16	Testis	423.3	328
Sample 17	Uterus	328	718
Sample 18	Cerebellum	480.4	424
Sample 19	Fetal Brain	91.02	54
Sample 20	Fetal Liver-1	6.059	18
Sample 21	Spinal cord	48.4	49
Sample 22	Placenta-1	160.2	217
Sample 23	Adrenal gland	86.29	84
Sample 24	Pancreas-1	0	0
Sample 25	Salivary gland	131.9	196
Sample 26	Thyroid	6.051	10

## SEQUENCE LISTING

&lt;110&gt; Bayer AG

&lt;120&gt; REGULATION OF HUMAN PHOSPHOLIPASE A2-LIKE ENZYME

&lt;130&gt; LIO169 Foreign Countries

&lt;150&gt; US 60/238,434

&lt;151&gt; 2000-10-10

&lt;150&gt; US 60/315,982

&lt;151&gt; 2001-08-31

&lt;150&gt; US 60/258,051

&lt;151&gt; 2000-12-27

&lt;160&gt; 11.

&lt;170&gt; PatentIn version 3.1

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Thr Asp Thr Ser His Pro Val Trp Asn Glu Ala Phe Arg Phe Leu Ile  
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 65 70 75 80

Ser Val Thr Glu Asp Asp Ile Cys Phe Lys Val Leu Tyr Asp Ile Ser  
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Glu Val Leu Pro Gly Lys Leu Leu Arg Lys Thr Phe Ser Gln Ser Pro  
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Gln Gly Glu Glu Glu Leu Asp Val Glu Phe Leu Met Glu Glu Thr Ser  
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Asp Arg Pro Glu Asn Leu Ile Thr Asn Lys Val Ile Val Ala Arg Glu  
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 180 185 190

Phe His Tyr Met Ala Ala Leu Glu Thr Glu Leu Ser Gly Arg Leu Arg  
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Leu Lys Gln Ala Leu Gln Leu Asp Arg Asp Leu Gln Glu Asp Glu Val  
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&lt;212&gt; PRT

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Thr Leu Asp Phe Lys Glu Trp Val Glu Phe Ser Pro Tyr Glu Val Gly
35           40           45

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Phe Leu Lys Tyr Gly Ala Phe Val Pro Pro Glu Leu Phe Gly Ser Glu
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Phe Phe Met Gly Arg Leu Met Arg Arg Ile Pro Glu Pro Arg Ile Cys
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Phe Leu Glu Ala Ile Trp Ser Asn Ile Phe Ser Leu Asn Leu Leu Asp
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Trp Asn Glu Thr Phe Glu Phe Ile Leu Asp Pro Asn Gln Ser Asn Val  
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Cys Asp Gln Glu Lys Leu Phe Met Gln Thr Arg Arg Asp Arg Val Met  
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 Lys Val His Asn Phe Met Leu Gly Leu Asn Leu Asn Ser Thr Leu Pro  
 485 490 495  
 Phe Ser Pro Phe Ser Gly Ile Thr His Gln Thr Ser Leu Glu Glu Glu  
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 610 615 620  
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 645 650 655  
 Phe Asp Ile Phe Asp Glu Pro Ala Ser Pro Tyr Ser Thr Phe Asn Phe

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665

670

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Asn Thr Leu Asn Asn Ile Glu Val Ile Lys Glu Ala Ile Lys Asp Ser  
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Ile Leu Leu Arg Arg Glu Asn Pro Ala Arg Cys Ser Val Ser Leu Ser  
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 Lys Arg Tyr Ile Glu Ala Leu Trp Asn Lys Lys Ser Ser Gly Gln Pro  
                     275                      280                      285  
 Val Thr Phe Thr Asp Ile Phe Gly Met Leu Ile Gly Glu Thr Leu Ile  
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 His Asn Arg Met Asp Thr Thr Leu Ser Asp Met Lys Glu Lys Val Ser  
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 Glu Ala Gln Cys Ala Leu Pro Leu Phe Thr Cys Leu His Val Lys Pro  
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 Met Glu Glu Glu Leu Glu Asn Ile Arg Leu Lys His Leu Val Ser Asn  
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 Asp Ser Ser Asp Ser Glu Asp Glu Ser Gln His Pro Lys Gly Thr Glu  
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 Gln Glu Ser Val Glu Glu Asp Glu Leu Asp Ala Ala Val Ala Asp Pro  
 515 520 525  
 Asp Glu Phe Glu Arg Ile Tyr Glu Pro Leu Asp Val Lys Ser Lys Lys  
 530 535 540  
 Ile His Ile Val Asp Ser Gly Leu Thr Phe Asn Leu Pro Tyr Pro Leu  
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Leu Asp Val Ile Lys Gln Ala Met Met Glu Ser Ile Glu Tyr Arg Lys  
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Glu Ser Arg Lys Arg Thr Arg His Ile Asn Asn Asp Ile Asn Pro Lys  
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Trp Asn Glu Thr Phe Glu Phe Ile Leu Asp Pro Asn Gln Ser Asn Val  
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Gly Thr Ala Lys Tyr Ser Leu Ser Lys Leu Lys Val Ala Gln Met Glu  
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Cys Asp Gln Glu Lys Leu Phe Met Gln Thr Arg Arg Asp Arg Val Met  
145 150 155 160

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Ser Ser Pro Arg Glu Val Pro Thr Ile Ala Ile Leu Gly Ser Gly Gly  
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Asn Pro Leu Lys Leu Leu Leu Pro Gln Asn Ile Asn Arg Tyr Val Lys  
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Leu Pro Leu Phe Thr Cys Leu His Val Lys Pro Asp Val Ser Glu Leu  
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Met Phe Ala Asp Trp Val Glu Phe Ser Pro Tyr Glu Ile Gly Met Ala  
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Lys Tyr Gly Thr Phe Met Ser Pro Gly Leu Phe Gly Ser Lys Phe Phe  
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Met Gly Ser Val Val Lys Gln Tyr Glu Glu Asn Pro Leu His Phe Leu  
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Met Gly Val Trp Gly Ser Ala Phe Ser Ile Leu Phe Asn Arg Val Leu  
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Lys Val His Asn Phe Met Leu Gly Leu Asn Leu Asn Ser Thr Leu Pro  
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Phe Ser Pro Phe Ser Gly Ile Thr His Gln Thr Ser Leu Glu Glu Glu  
500 505 510

Val Asp Ala Val Thr Asp Pro Asp Glu Phe Glu Arg Ile Tyr Glu Pro  
515 520 525

Leu Asp Val Lys Ser Lys Lys Ile His Val Val Asp Ser Gly Leu Thr  
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Phe Asn Leu Pro Tyr Pro Leu Ile Leu Arg Cys Gln Arg Gly Val Asp  
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Leu Ile Ile Ser Phe Asp Phe Ser Ala Arg Pro Ser Asp Ser Ser Pro  
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Pro Phe Lys Glu Leu Leu Leu Ala Glu Lys Trp Ala Arg Met Asn Lys  
580 585 590

Leu Pro Phe Pro Lys Ile Asp Ser Lys Val Phe Asp Arg Glu Gly Leu  
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Lys Glu Cys Tyr Val Phe Lys Pro Ala Lys Gly Asp Lys Asn Cys Pro

610

615

620

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Ala Pro Gly Val Pro Arg Asp Ser Asp Lys Asp Ile Glu Phe Gly Asp  
645 650 655

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Glu Glu Gln Ala Phe Leu Ser Arg Arg Lys Gln Val Val Ala Lys Ala  
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Leu Lys Gln Ala Leu Gln Leu Asp Arg Asp Leu Gln Glu Asp Glu Val  
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Pro Val Val Gly Ile Met Ala Thr Gly Gly Gly Ala Arg Ala Met Thr  
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Ser Leu Tyr Gly His Leu Leu Ala Leu Gln Lys Leu Gly Leu Leu Asp  
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Cys Val Thr Tyr Phe Ser Gly Ile Ser Gly Ser Thr Trp Thr Met Ala  
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His Leu Tyr Gly Asp Pro Glu Trp Ser Gln Arg Asp Leu Glu Gly Pro  
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Ile Arg Tyr Ala Arg Glu His Leu Ala Lys Ser Lys Leu Glu Val Phe  
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Ser Pro Glu Arg Leu Ala Ser Tyr Arg Arg Glu Leu Glu Leu Arg Ala  
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Glu Gln Gly His Pro Thr Thr Phe Val Asp Leu Trp Ala Leu Val Leu  
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Glu Ser Met Leu His Gly Gln Val Met Asp Gln Lys Leu Ser Gly Gln  
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Arg Ala Ala Leu Glu Arg Gly Gln Asn Pro Leu Pro Leu Tyr Leu Ser  
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Leu Asn Val Lys Glu Asn Asn Leu Glu Thr Leu Asp Phe Lys Glu Trp  
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Glu Lys Glu Pro Leu Thr Thr Ser Gly Thr Ser Ser Arg Leu Glu Ala	545		550		555
Ser Trp Leu Gln Pro Gly Thr Ala Leu Ala Gln Ala Phe Lys Gly Phe	565		570		575
Leu Thr Gly Arg Pro Leu His Gln Arg Ser Pro Asn Phe Leu Gln Gly	580		585		590
Leu Gln Leu His Gln Asp Tyr Cys Ser His Lys Asp Phe Ser Thr Trp	595		600		605
Ala Asp Tyr Gln Leu Asp Ser Met Pro Ser Gln Leu Thr Pro Lys Glu	610		615		620
Pro Arg Leu Cys Leu Val Asp Ala Ala Tyr Phe Ile Asn Thr Ser Ser	625		630		635
Pro Ser Met Phe Arg Pro Gly Arg Arg Leu Asp Leu Ile Leu Ser Phe	645		650		655
Asp Tyr Ser Leu Ser Ala Pro Phe Glu Ala Leu Gln Gln Thr Glu Leu	660		665		670
Tyr Cys Arg Ala Arg Gly Leu Pro Phe Pro Arg Val Glu Pro Ser Pro	675		680		685
Gln Asp Gln His Gln Pro Arg Glu Cys His Leu Phe Ser Asp Pro Ala	690		695		700
Cys Pro Glu Ala Pro Ile Leu Leu His Phe Pro Leu Val Asn Ala Ser	705		710		715
Phe Lys Asp His Ser Ala Pro Gly Val Gln Arg Ser Pro Ala Glu Leu	725		730		735

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